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1890.

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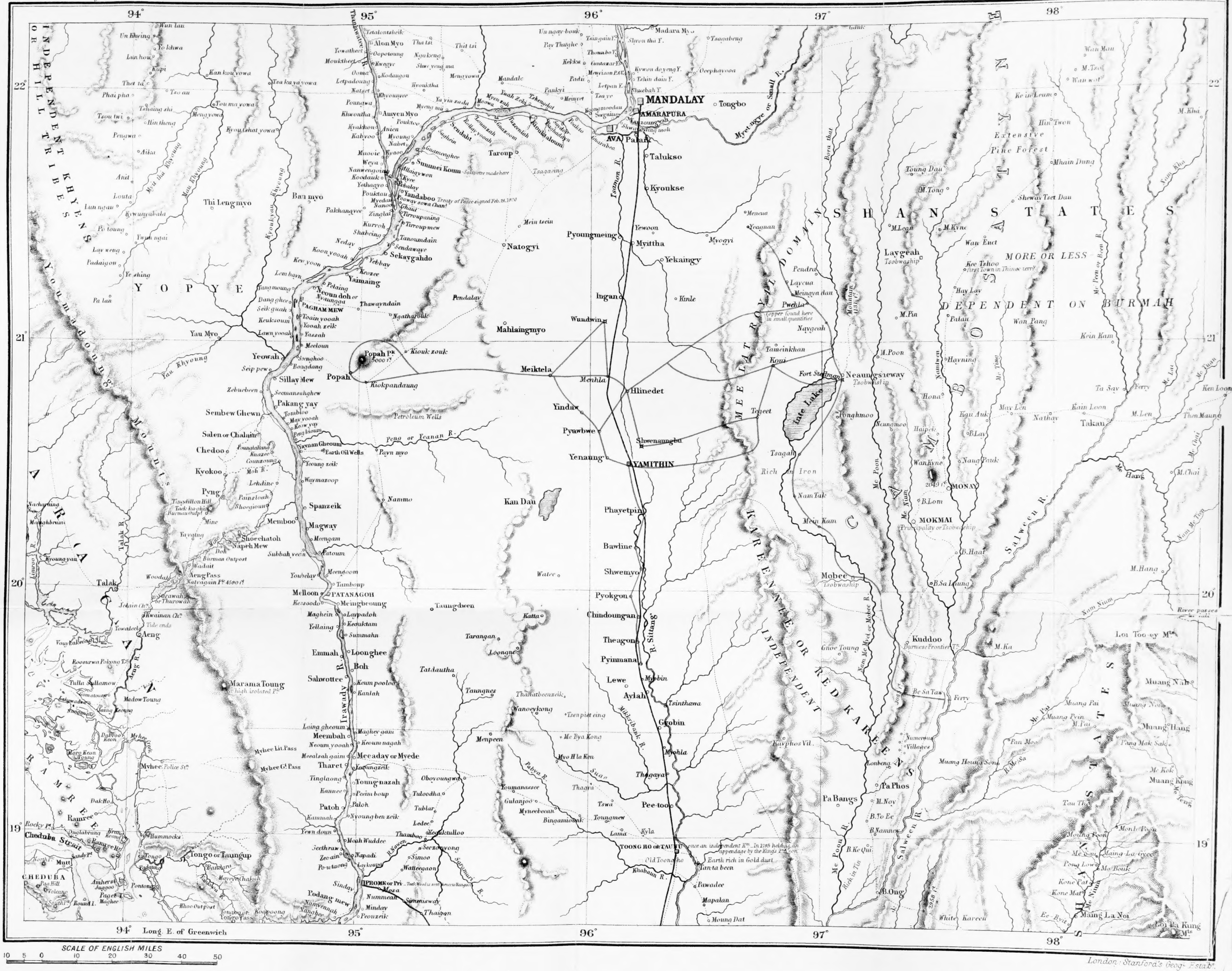

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THE LINNEAN SOCIETY.

On a Collection of Plants from Upper Burma and the Shan States. By Brigadier-General H. Collett, C.B., F.L.S., and W. Botting Hemsley, F.R.S., A.L.S.

[Read 7th November, 1889.]

(Plates I.-XXII., and Map.)

Introduction.
(By General Collett.)

I propose to communicate to the Linnean Society some particulars of a collection of plants made in 1887 and 1888 in the neighbourhood of Meiktila, in the plains of Upper Burma, and in the Southern Shan States, on the eastern frontier of that province. I began collecting plants in this region partly to gratify my own love for botany, and partly in response to the request of my friend Dr. G. King, F.R.S.

From time to time, as the plants were collected, they were transmitted to Calcutta and incorporated in the general herbarium there; for I had then no idea of publishing any account of them. Dr. King and his assistant, Dr. D. Prain, compared and approximately named the species that I had failed to identify, and they were many, and furnished me with the names, from which it appeared that I had collected a number of novelties. I also learned that nothing had been published on the botany of the Shan hills. Under these circumstances, and encouraged by

Dr. King, I decided that the collections should be worked out critically. This has been done at Kew by my friend Mr. Hemsley; and I am told, by those better able to give an opinion on this subject than I am, that the results and particulars are of sufficient scientific interest for publication. I therefore submit this paper to the Society in the hope that I may thus, in some humble measure, advance the science of systematic and geographical botany.

As I have already mentioned, my original object was not publication, consequently I did not observe and note with that exactitude I should otherwise have done, and I have to solicit the indulgence of the Society for any shortcomings due to this cause.

As soon as it was decided to publish an account of the collection, Dr. King and his assistant, Dr. Prain, cheerfully undertook the laborious task of going through the Calcutta Herbarium to take out the specimens previous to sending them to Kew. The critical comparison they have been subjected to there has revealed the existence of a much larger number of new forms than was anticipated, and a few of the most remarkable are here exhibited for the inspection of the Fellows.

The collection is, of course, very far indeed from a complete representation of the flora of those little-known regions, but it may serve as a fair sample of the composition of the vegetation.

Excluding a few probably introduced plants, and the Grasses, which were sent to Mr. Duthie, F.L.S., Superintendent of the Saharunpore Botanic Garden (who is making a special study of this natural order), and have not reached England at the time of writing, the total number of species of Phanerogams enumerated is about 725, belonging to 460 genera and 109 natural orders*. But before proceeding to Mr. Hemsley's analysis of the relationships and geographical distribution of the elements of this sample of the flora, I will give some of the more salient

* The enumeration, it should be stated, also includes some plants collected for me by Surgeon N. Manders, of the Medical Staff, while he was attached to the Southern Shan Column during the cold season of 1887–88, and while quatered at Koni in the Shan hills during the summer of 1888. Mr. Manders collected several interesting novelties, and his name is appended to all the plants he collected. We have likewise added, with the assent of the collector, a few plants collected by Mr. Aplin, of the Indian Forest Department, and reported on by him to the Chief Commissioner of Burma.

features of the physical characters of the country and the aspects of the vegetation.

Concerning the plants from the plains of Upper Burma little need be said. Griffith and Wallich collected in the neighbourhood of Ava fifty years ago, and there are not many novelties from this region—the plants being chiefly of the same species discovered by those botanists, yet often valuable, because affording better material of obscure species founded upon imperfect specimens.

The general character of the flora of Lower Burma is sufficiently well known from the researches of Kurz, Parish, and other botanists, but it differs widely from that of Upper Burma, due to the very different climatal conditions prevailing in the two regions. In Lower Burma the annual rainfall is seldom much short of 100 inches, and it nourishes a purely tropical vegetation; whereas in the wide and arid plains which form the greater part of Upper Burma the rainfall diminishes to a yearly average of about 30 inches, and the general aspect of the vegetation bears a striking resemblance to that of the dry plains of the Deccan in Southern India.

The Shan Hills and Plateaux.

We have here to deal with a more interesting and novel area, which had never before been botanically explored, and which has yielded, even in the partial collections now under review, a remarkably large number of new and interesting plants, amounting indeed to about 12·5 per cent.

The petty provinces comprising the territory known as the Shan States, or Shan Hills, extend along the entire eastern frontier of our Burman possessions, from the Chinese province of Yunnan on the north and north-east to Siam in the south; and consist, speaking broadly, of several distinct ranges of hills, rising in occasional peaks to a height of 6000 or 7000 feet, and running north and south, enclosing elevated plateaux of from 3000 to 4000 feet above the sea-level. The Shan States are divided for administrative purposes into Northern and Southern; and it is the latter division with which we are immediately concerned, as it is almost exclusively in this area that the present collection of plants was made.

The States may be roughly defined as comprised between the

19th and 22nd parallels of North latitude, and as bounded on the east by the Salween river, and on the west by the plain of Upper Burma.

Along the whole western border of this mountainous region runs the belt of jungle locally known as "the *terai*," which interposes its malarious valleys between the plain country and the healthy plateaux of the interior hills. This fringe of forest, or *terai*, presents the usual features characteristic of similar belts of jungle bordering the foot of the Himalayas, from north-east to south-west. Up to about 2000 or 2500 feet of elevation the forest is dry, the soil poor, and the trees more or less stunted in their growth, forest-fires being of frequent occurrence. Undergrowth is almost absent, and bamboos and Dipterocarps, associated with species of *Stereospermum* and *Dillenia* and a few climbers, such as *Spatholobus* and *Congea tomentosa*, are the most prominent features of the vegetation.

On attaining a higher elevation, from about 2500 to 4000 feet, the character of the vegetation is much changed, owing in part to the greater humidity, in part to a lower temperature. The trees are much larger; mosses, lichens, and ferns abound; the hill-sides are covered with undergrowth, and numerous trees and herbaceous plants appear which are not represented at lower levels: such are *Quercus*, *Schima Wallichii*, and two or three arboreous *Compositæ*. This is the principal forest, from the gloomy depths of which the traveller passes, at about 3500 or 4000 feet of elevation, by one step, to the open breezy plateaux intervening between the forest edge and the next range of mountains. It causes a pleasant feeling, after marching for two or three days along narrow paths, cut through dense jungle, and breathing a stagnant atmosphere, to mount the last ascent and emerge, quite unexpectedly, into the cheerful light of day, seeing before one rounded grassy hills, with occasional clumps of oak or pine, and crowned in the blue distance with the picturesque pagodas of some Shan village. It is the plants of these rolling plateaux, and of the precipitous limestone hills which rise above them, that have yielded the greater number of the novelties described in this paper.

The general geological formation of the plateaux is a water-worn limestone, with occasional interposed sheets and boulders of conglomerate, underlying a sedimentary deposit of fine-grained red clay or loam, varying in thickness from a thin super-

ficial covering up to three or four hundred feet, according to the amount of denudation it has undergone. This mantle of red clay at one time certainly overspread the whole country, probably at a nearly uniform level, for patches of it, like raised beaches, are seen clinging to sheltered hollows in the black limestone ridges which rise through it in long parallel folds—remnants, no doubt, marking the ancient level of the red clay, as deposited in the quiet depths of an ocean or large lake. The underlying limestone, wherever exposed to view, is seen to have been worn into rounded hollows and projecting bosses, apparently by the action of water, at a time when it was exposed to denudation; and, like limestone in other parts of the world, it is full of clefts, crevices, and caverns, communicating with each other to form subterranean channels into which a great part of the superficial drainage of the country disappears.

The rainfall of the Shan plateaux has not yet been determined with any approach to accuracy, owing to the short period which has elapsed since the British occupation of the country, but it certainly considerably exceeds that of Upper Burma. From the few available records it may be roughly estimated that the annual fall in the Southern Shan States averages about sixty inches, the greater part being precipitated between the months of May and September, though occasional showers fall during the rest of the year. Still, the general aspect of the vegetation, especially the few species of ferns which are found, show that the climate is not persistently damp, and that in this respect it differs much from that prevailing in the lower valley of the Irrawaddy and in the Tenasserim hills.

On quitting the border of the forest and entering the plateaux, the traveller is at once struck by the temperate character of the flora. Species of *Ranunculus*, *Clematis*, *Viola*, *Polygala*, *Hypericum*, and *Swertia* are common plants, while bushy Lespedezas, large flowering Asters, tall Labiates, and showy Ipomœas give the vegetation a more specially Asiatic character. Among the trees, oaks and pines are the most common and conspicuous. No less than nine species of oak have been collected; and this genus forms a considerable proportion of the trees in the upper part of the terai forest, as well as of the woods clothing the sides of the hill-ranges. The common pine of the Southern Shan hills is *Pinus kasya*, which extends from the Khasia hills in Assam to Martaban on the coast of Tenasserim. It never, so far as I

know, forms extensive forests of itself, but occurs in small clumps, or even as single trees, scattered over the grassy downs. The wood is remarkably resinous, and is much used as fuel and for torches.

The beautiful *Schima Wallichii*, with white camellia-like flowers, and a member of the same natural order as the camellia, is also a common tree, especially on the western border of the plateau. Only two species of *Rosa* were seen, and both are new. The beautiful *R. gigantea* is particularly conspicuous, climbing over tall forest trees, from the top of which the long pendent branches, covered with very large white flowers, hang down in rich profusion. This rose, which has larger flowers probably than any other wild species, is seen from considerable distances in the jungle, reminding one more of a large-flowered clematis than of a rose. Though apparently spread over the whole Shan hills, and extending to Muneypore in the north, where it was previously found by Dr. George Watt, it is only locally abundant, chiefly in dark shady valleys. It is most nearly allied to *R. indica*, which has recently been found wild in China, and is perhaps only a fine variety of that species. Vigorous young plants, raised from seed collected by myself, are now flourishing in Kew Gardens.

The other new rose, *Rosa Collettii*, Crépin, is less common; but where it occurs it grows vigorously and is a profuse flowerer. It is never found far from water, and seems to prefer the banks of streams, where I have found it growing almost to the exclusion of other suffruticose vegetation. A big honeysuckle, *Lonicera Hildebrandiana*, is, so far as I am aware, a rare plant, though I have been told that the flowers of this species are much used in decorating the temples at Pindiah, near Pwehla. I found it only in one locality, at a season when unfortunately it was almost past flowering, and when the fruit was not sufficiently mature to contain perfect seeds. It is a conspicuous shrub with large, dark, glossy leaves and fine crimson flowers seven inches long, and by far the largest of any known species of honeysuckle. It is much to be desired that seeds of this beautiful shrub may yet be secured and the plant raised for the adornment of our gardens. A very common and conspicuous bush, on certain parts of the plateau, is the curious *Osteomeles anthyllidifolia*, a shrub nearly allied to *Pyrus*, and in general appearance strongly resembling our English blackthorn. Thick bushes of this shrub

are covered in spring with small, pretty, white flowers, contrasting well with its dark green finely-pinnate leaves. It is much browsed by cattle in the neighbourhood of villages, and then assumes a stunted, thick-set habit, reminding one, from a distance, of furze bushes on an English common. Although spread over the whole plateau of the Southern Shan States, it is only common in particular localities, where it sometimes forms extensive thickets.

A tall, bushy *Lespedeza* (*L. Prainii*), bearing large, dense terminal panicles of fine blue flowers, is another common and conspicuous plant, and would be well worth cultivation in our shrubberies, if sufficiently hardy.

Compositæ are more largely represented than might have been expected, in a region regarded as relatively poor in the order, amounting to nearly eight per cent. of the collection. Ten out of thirteen tribes are represented, and many fine species beautify the grassy plateaux during the rainy season and early autumn. The curious Euphorbia-like, fleshy-stemmed *Notonia*, bearing handsome yellow flowers, is not uncommon on the higher levels; and there is a singular prostrate variety which trails over the rocks in a very remarkable manner.

Two species of arboreous *Compositæ* are common; one of them, *Vernonia Aplinii*, is new, and attains a height of over twenty feet with a relatively stout trunk. It is common in the upper region of the forest, at elevations of about 3000 feet. The other, *Leucomeris decora*, a member of the *Mutisiaceæ*, a group very sparsely represented in Asia, is also found in other hilly parts of Burma, but is more usually met with in the forests clothing the sides of the hills and ravines in the interior of the mountains.

Another plant worthy of notice is the singular endemic campanulaceous *Codonopsis convolvulacea*, first described by Kurz. It is common over the whole Shan plateau—its wiry stems creeping among grass, round the culms of which it twines, until it attains air and sunlight, when it expands its beautiful dark blue convolvulus-like flowers.

Among the *Primulaceæ* the pretty little *Primula Forbesii*, previously recorded only from the neighbouring Chinese province of Yunnan, and botanically interesting as forming a connecting-link between the genera *Primula* and *Androsace*, deserves mention. It grows abundantly in almost every damp locality

throughout the Shan States, being equally at home in the shady depths of a forest and on the ridges raised to divide irrigated rice-fields. Though of small stature, it is of remarkably vigorous growth, often bearing two or even three distinct whorls of flowers. I have found it in flower in some situation or other in every month of the year; in this respect, as well as in its general aspect, strongly reminding one of its North-west Himalayan congener *P. floribunda*; but it is an annual.

The *Convolvulaceæ* are numerously represented in the Shan hills, constituting more than 3·5 per cent. of the collection. The genera *Lettsomia* and *Ipomœa*, in particular, form a conspicuous part of the flora. Of the latter genus our new *I. nana* presents some curious and unusual characters. It is a small erect plant, six to twelve inches high, growing among the grass on the level plateau or on dry hill-sides. The flowers are large, of a beautiful deep purple, and are usually hidden among the grass-stems, which they rarely overtop. The root is very thick and woody; and the flowers strongly resemble those of an allied species, also new, which we have named *I. popahensis*, from its being found on the isolated Popah mountain, which is of volcanic origin and elevated about 5000 feet above the plains of Upper Burma. *Ipomœa popahensis* also grows among grass, but is distinguished from its congener by having a weak stem which twines round the culms of grasses and other plants.

I much regret that I had only one day's botanizing on Mount Popah, and that in the month of December, a most unproductive season, for it would be very interesting to compare the plants of this hill, which has certainly been isolated since early Tertiary times, with those of the Shan hills, separated therefrom by about fifty miles of flat country, some eight hundred feet only above sea-level.

Among the numerous *Labiatæ* of the Shan hills, *Colquhounia elegans* is certainly the most beautiful. This fine plant is only recorded from Burma, and in our area attains a height of eight to ten feet. It is described by Kurz as "a scandent or half-scandent shrub," but in the Shan hills it is certainly erect, and is often seen standing above the low bushes among which it grows. There are two varieties of it, inhabiting distinct areas; but as they differ only in the colour of their flowers, one being dark red and the other pale salmon, we have not distinguished them in the enumeration. This shrub is very common all over

the Shan plateaux, and its seeds would be well worth collecting for cultivation in England.

The trees in the upper forest-region, from about 4000 to 5000 feet, are much infested by parasitic plants, belonging for the most part to the natural order *Loranthaceæ*, two of which, *Loranthus Hemsleyanus*, King, and *L. Collettii*, King, with showy dark crimson flowers, are new. To such an extent does parasiticism prevail, that there are phanerogamous parasites preying upon parasites of close affinity. A new species of *Phacellaria* (*P. caulescens*), a parasitic genus, belonging to the allied order *Santalaceæ*, was found growing on a branch of a *Loranthus*, itself parasitic on an oak—a rare phenomenon in the economy of plant life, which, however, has a proverbial parallel in the animal kingdom. A second species, *P. compressa*, was found growing on *Viscum monoicum*.

Orchideæ.

Among the Orchideæ are several novelties, two of which are highly curious and merit further notice. *Cirrhopetalum Collettii*, Hemsl., is a most singular plant, bearing five or six dark purple flowers in an umbel at the summit of a scape two or three inches high. The flower has little or no odour, and is remarkable for its extremely long attenuated sepals, which are highly mobile and are wafted about by the slightest breath of air. They are also furnished with a number of little streamers or banner-like appendages, which, as Darwin remarks of an allied *Bulbophyllum*, "when blown by a breath of wind wriggle about in a very odd manner."

Whether these wonderfully elaborate arrangements have the effect of attracting the notice of passing insects, or what other purpose they may serve, might form a subject for interesting speculation; and I much regret that the small opportunities I had of observing the plant do not admit of my forming any theory on the subject. Suffice it to say that the spectacle of the long narrow sepals and the little streamers all waving about together is extremely fantastic and curious, and will, I hope, soon be seen in England, as there are some healthy plants of this species now growing at Kew.

The other new orchid referred to is *Bulbophyllum comosum*, remarkable for the dense, bottle-brush-like raceme of flowers

terminating the curved stout scape; in this character quite unlike any other known species of the genus. The flowers are very sweet-scented, and are much prized by the Shan maidens for ornamenting their hair. The plant is very common in some localities, and I have often seen its flowers exposed for sale in the village bazaars. Unfortunately, under the impression that it was well-known, I did not take the trouble to send home living plants, and even my dried specimens are imperfect, wanting both leaves and pseudobulbs.

Cultivation.

Cultivation on the Shan plateaux consists of rice, both the common sort grown in irrigated fields, as in the low country, and the hill variety, which matures its grain on unirrigated land. Indian corn, cotton, tobacco of very fine quality, and several species of millet and pulse are also common crops here as well as in Upper Burma.

The methods of cultivation pursued in the Shan hills are more advanced than one would have expected, and the people by their ready adoption of potatoes and wheat have shown that they are quite willing to effect improvements. The fields are scrupulously cleared of weeds, which are collected into heaps and burned, the ashes being afterwards mixed with manure and spread over the surface of the ground.

A curious custom, prevailing throughout the whole country, which I have not seen elsewhere, is the treading in by cattle of the seed after it has been sown broadcast over the ploughed fields, instead of using the harrow. I have frequently seen a man with a couple of dogs driving a small herd of ten or twelve cattle to and fro in a ploughed field, and it was at first sight rather difficult to understand what they were doing. The results are satisfactory, as the crops of rice, Indian corn, &c. are always good in favourable seasons.

The Shan people are naturally a very quiet and industrious race, and all they ask is to be left in peace to cultivate their fields. For many years past the country has been the scene of strife and anarchy—a state of things entirely due to the personal ambition and the quarrels of the numerous petty chieftains who have held the country divided among them. There can be no doubt that the *pax Britannica*, which is now enforced in these

remote regions, will result in the greater happiness and contentment of the people

In concluding this part of the introduction, I wish to record my obligations and thanks to Mr. Thiselton Dyer, the Director of Kew Gardens, for permitting the use of the Herbarium and Library, and other advantages of the establishment under his charge, for the purpose of working out my collection. I have also much pleasure in testifying to the great care and skill bestowed on the drawings by Miss M. Smith, and to the equally careful work of Mr. Charles Fitch in transferring them on to stone.

Statistics and Distribution of the Plants.
(By Mr. Hemsley.)

The collection of plants under review is not sufficiently comprehensive to afford data for an exhaustive analysis of the flora of Upper Burma and the Southern Shan hills; but it has brought to light some interesting facts that may be worth bringing under the notice of the Society. As General Collett has already stated, the Grasses had not reached England at the time of writing this, and are therefore not included in the following numbers and comparisons. It may be repeated here that the collection comprises about 725 species of flowering plants, belonging to 460 genera and 109 natural orders. These proportions closely approach those obtaining in many insular floras, but they may be, and probably are, wide of the actual proportions in the whole flora of the Shan hills. Nevertheless, it is a remarkable fact that in this collection, which is not to be regarded as a selection, the species are to genera about as 1·6 to 1; and many of the natural orders, even some of those relatively numerous in species, are represented by nearly as many genera as species. Thus, of the *Asclepiadeæ*, there are fifteen species belonging to fourteen genera; and no fewer than 328 of the 460 genera are represented by a single species each. On the other hand, a few genera are relatively large in species; these are:—

	Species.		Species.
Ipomœa	14	*Desmodium*	6
Capparis	10	*Indigofera*	6
Quercus	9	*Polygala*	5
Vitis	9	*Millettia*	5
Crotalaria	7	*Bauhinia*	5
Strobilanthes	6	*Loranthus*	5

The twelve largest natural orders are:—

	Genera.	Species.		Genera.	Species.
Leguminosæ	38	83	Convolvulaceæ	9	25
Compositæ	34	57	Verbenaceæ	13	21
Labiatæ	23	40	Scrophularineæ	12	18
Acanthaceæ	16	29	Asclepiadeæ	14	15
Rubiaceæ	18	28	Cappardeæ	3	12
Euphorbiaceæ	18	26	Ranunculaceæ	6	8

With the exception of the *Capparideæ*, these orders occupy something closely approaching their relative positions in the flora of India and in the flora of the whole world. The orders represented in the collection by only one species are:—Dilleniaceæ, Cruciferæ, Bixineæ, Pittosporeæ, Tamariscineæ, Zygophylleæ, Simarubeæ, Ochnaceæ, Burseraceæ, Coriarieæ, Samydaceæ, Ficoideæ, Cornaceæ, Plumbagineæ, Salvadoraceæ, Solanaceæ, Orobanchaceæ, Plantagineæ, Aristolochiaceæ, Piperaceæ, Chloranthaceæ, Proteaceæ, Elæagnaceæ, Juglandaceæ, Salicineæ, Cycadaceæ, Irideæ, Pontederiaceæ, Alismaceæ, Naiadaceæ, and Eriocauleæ; or nearly one third of the total. That the Cruciferæ should be represented by *Cardamine hirsuta* only is perhaps the most striking and unexpected fact brought out by this list, though Cruciferæ are also rare in the Khasia hills.

An examination of the distribution of the genera shows that there is scarcely any endemic element. There is the curious little uniovulate papilionaceous *Neocollettia*; *Atherolepis*, *Adelostemma*, and *Physostelma* in Asclepiadeæ; *Blinkworthia* in Convolvulaceæ; and *Cystacanthus* in Acanthaceæ; and we have exhausted the number of generic types in the collection that are restricted to the region, even if we extend it southward to Singapore.

Out of 460 genera, 122 are generally dispersed, either in the tropics or in temperate and subtropical regions; and 96 are widely spread, that is to say they occur in some part of America, besides having a considerable range in the Old World. Excluding these 218 genera, 213 extend to North India, 166 to the Malay Archipelago, 136 to China, 90 to Australia, 36 to Polynesia, and 82 to Africa. Adding the number of genera from North India to those of wide range, we have 431—thus leaving a very small number that extend to only one of the other regions named. These figures therefore go to show how very wide are the areas of the majority of northern genera.

Descending to species, the results are very different. Out of about 725, only 15 are generally diffused, and 16 others have a wide range; 461 extend to North India; 280 to South India; 223 to the Malay Archipelago; 181 to China; 71 to Australia; 12 to Polynesia; and 64 to Africa. With regard to the specific endemic element, 177 species, or nearly a quarter of the whole collection, appear to be restricted to Burma and the Malay peninsula; and about 90 of them were, so far as we could ascertain, previously undescribed. Of course, further investigations in the adjoining regions may materially reduce this proportion; but, judging from results obtained recently in Western and Central China, it is not probable. And after all, this is not a high percentage compared with what is known of other subtropical regions.

The apparent absence in North and Central India of plants common to South India (the peninsula) and Burma is noteworthy. The genera *Hopea*, *Berrya*, *Notonia*, and *Azima* are of this class; and about 25 species have not been found in the connecting or intermediate region. Of these *Cardiospermum Corindum*, *Blepharis boerhaaviæfolia*, and *Priva leptostachya* also extend to Africa. In addition, there is a number of representative species in the two areas: such are *Ceropegia nana* and *Brachystelma edulis*. Specially interesting among the novelties are:—*Impatiens ecalcarata*, *Pistacia coccinea*, *Neocollettia gracilis*, *Phylacium majus*, *Vernonia gymnoclada*, *Physostelma carnosa*, *Onosma burmanica*, *Ipomœa nana*, *Phacellaria caulescens*, and the exceedingly curious orchids *Cirrhopetalum Collettii* and *Bulbophyllum comosum*. The only previously known species of the very marked leguminous genus *Phylacium* has a wide range in the Malay Archipelago. Equally remarkable, geographically, is *Anisopappus chinensis*, which is also a native of South-eastern China and Eastern and Western tropical Africa, though unknown from any part of India.

Osteomeles anthyllidifolia is another most interesting discovery. This shrub is widely spread in Polynesia, eastward to the Sandwich group and Pitcairn Island. There are also specimens in the Kew Herbarium from the Bonin Islands; and it is recorded from Japan and the Luchu Archipelago. All the other species of the genus inhabit the Andes of South America.

The most interesting point, perhaps, connected with this collection has been left to the last. It is the large number of temperate types it contains from comparatively low elevations. Sir

Joseph Hooker * observed the same thing in the investigation of the Khasia hills, where, he states, many genera and species appear on naked and exposed moor-like uplands at 5000 to 6000 feet which are not found on the outer ranges of Sikkim under 10,000 feet. "In fact," he continues, "strange as it may appear, the temperate flora descends fully 4000 feet lower in the latitude of Khasia (25° N.) than in that of Sikkim (27° N.), though the former is two degrees nearer the equator."

The Southern Shan hills are actually within the tropic, lying between 19° and 22° N., and there temperate types appear in abundance at 4000 feet. Indeed, in looking through the enumeration, it would seem that temperate types prevail at that elevation, some descending even lower. Among those occurring at 4000 feet are *Thalictrum*, *Anemone*, *Delphinium*, *Silene*, *Stellaria*, *Hypericum*, *Impatiens*, *Agrimonia*, *Poterium*, *Epilobium*, *Œnanthe*, *Galium*, *Echinops*, *Primula*, *Fraxinus*, *Pedicularis*, *Mentha*, and *Ajuga*. In short, 85, or about one fifth of the genera represented in the collection, are British. The combination of causes producing this result we are unable to explain, but the comparatively small rainfall has probably had much to do with it.

Gramineæ.

(By Mr. Hemsley.)

Since the foregoing was read before the Society, the Grasses have been received and determined. They number about eighty species, all of them probably previously described, though there are three or four well-marked forms referred with doubt to the nearest allied species. Taken as a whole, the grasses are of a more tropical type than the rest of the collection †, belonging largely to the tribe *Andropogoneæ* and the genera *Panicum* and *Eragrostis*. Specially interesting of the tribe in question is the little-known *Ratzeburgia pulcherrima* of Kunth, the *Aikinia elegans* of Wallich's 'Plantæ Asiaticæ Rariores,' t. 273. In the letterpress (vol. iii. p. 46), Wallich describes it as without exception the most lovely and elegant grass that he had ever seen, being of a pale glaucous colour, and the crest of the outer

* 'Himalayan Journals,' ed. 1, ii. p. 281.

† This is explained by the fact that a larger proportion of this natural order was collected near Meiktila on the plain in Upper Burma.

glume of a pinkish tint. The specimens now obtained from near Meiktila are much finer and more robust than those upon which the genus was founded. A new species of the genus *Enteropogon*, or a marked variety of *E. melicoides*, Nees, previously only known from South India and Ceylon, was collected at Meiktila. From the same region, too, there is a remarkable variety of *Eragrostis viscosa*, Trin., also a South-Indian grass; or it may deserve to rank as an independent species. An elegant variety of *Sporobolus coromandelianus*, Kunth, completes the list of specially interesting grasses.

Enumeration of the Plants, together with their Distribution, and Descriptions of the New Species *.

(By General Collett and Mr. Hemsley.)

Ranunculaceæ.

Clematis grewiæflora, *DC.*; *Fl. Brit. Ind.* i. p. 6.—Shan hills plateau at 4000 feet.

Mountains of North India, from Kumaon eastward.

Dr. Kuntze (Monogr. p. 130) unites this, as a variety, with *C. Buchananiana*, DC.; and there are intermediate forms that might with equal propriety be referred to either.

Clematis Gouriana, *DC.*; *Fl. Brit. Ind.* i. p. 4; *Forest Fl. Burma*, i. p. 16.—Koin, at 4400 feet, *Manders*.

Western Himalaya to Ceylon, and Malayan peninsula and archipelago, and probably also Central China.

Clematis grata, *Wall.*, var. foliolis subintegris; *Fl. Brit. Ind.* i. p. 3.—Fort Stedman, 3000 feet, *Manders*.

Afghanistan, through Northern India to China, and in the mountains of Tropical Africa.

Naravelia zeylanica, *DC.*; *Fl. Brit. Ind.* i. p. 7; *Forest Fl. Burma*, i. p. 18.—Meiktila.

Widely spread in India, and extending to the Malayan archipelago and South China.

* Throughout this enumeration references are given to Hooker's 'Flora of British India,' as far as it is published, to Kurz's 'Forest Flora of British Burma,' and occasionally, where it seemed desirable, to other works.

Thalictrum minus, *Linn.*, var.; *Fl. Brit. Ind.* i. p. 14.—Shan hills, 4000 feet.

Europe, North and Central Asia to Japan, and North and South Africa.

Anemone rivularis, *Ham.*, var. floribus minoribus numerosioribus; *Fl. Brit. Ind.* i. p. 9.—Shan hills at 4000 feet.

Widely spread in the temperate regions of India and Ceylon, and recently collected in Western China.

Dr. G. Watt collected the same variety in Muneypore.

Ranunculus pensylvanicus, *Linn.*; *Fl. Brit. Ind.* i. p. 19.—Shan hills, common.

Kashmir to the Khasia hills, China southward to Canton, and in Mandshuria as well as in North America.

Delphinium altissimum, *Wall.*; *Fl. Brit. Ind.* i. p. 25.—Shan hills at 4000 feet.

Central Himalaya and Khasia hills.

DILLENIACEÆ.

Dillenia pulcherrima, *Kurz, Forest Fl. Burma*, i. p. 19; *Fl. Brit. Ind.* i. p. 37.—Shan hills terai.

Prome, Pegu, and Martaban.

Expanded flowers of this species were previously unknown at Kew.

MAGNOLIACEÆ.

Manglietia insignis, *Blume*; *Fl. Brit. Ind.* i. p. 42; *Forest Fl. Burma*, i. p. 25.—Shan States, Bauzan.

Nepal, Khasia, and Pegu.

Good flowering specimen of a white, broad-leaved variety.

Schizandra axillaris, *Hook. f. et T. Thoms.*; *Fl. Brit. Ind.* i. p. 45.—Shan hills at 4000 feet.

Khasia hills and Java.

ANONACEÆ.

Uvaria purpurea, *Blume*; *Fl. Brit. Ind.* i. p. 47; *Forest Fl. Burma*, i. p. 27.—Shan hills terai.

Eastern India, Malayan peninsula and archipelago.

Artabotrys odoratissimus, *R. Br.*; *Fl. Brit. Ind.* i. p. 54;

Forest Fl. Burma, i. p. 31.—In a monastery garden, perhaps cultivated.

South India and Ceylon, Malayan archipelago, and South China; and cultivated throughout India.

Polyalthia cerasoides, *Benth. et Hook. f.*; *Fl. Brit. Ind.* i. p. 63; *Forest Fl. Burma*, i. p. 38.—Meiktila.

South India and Prome.

Miliusa velutina, *Hook. f. et T. Thoms.*; *Fl. Brit. Ind.* i. p. 87; *Forest Fl. Burma*, i. p. 47.—Meiktila.

Widely spread in tropical India and Malaya.

MENISPERMACEÆ.

Cocculus laurifolius, *DC.*; *Fl. Brit. Ind.* i. p. 101.—Shan hills, Hopou valley.

Subtropical Himalayan region and Java and Japan; perhaps only cultivated, or an escape from cultivation, out of India.

Cocculus mollis, *Wall.*; *Fl. Brit. Ind.* i. p. 102.—Shan hills at 5000 feet.

Nepal and Khasia hills.

Cocculus villosus, *DC.*; *Fl. Brit. Ind.* i. p. 101.—Meiktila.

Throughout tropical and subtropical India, from the Himalayas to Malabar and Pegu; and also in tropical Africa.

Stephania hernandifolia, *Walp.*, var.?; *Fl. Brit. Ind.* i. p. 103.—Shan hills at 5000 feet.

Tropical Asia, Africa, and Australia.

BERBERIDACEÆ.

Berberis nepalensis, *Spreng.*; *Fl. Brit. Ind.* i. p. 109; *Forest Fl. Burma*, i. p. 58.—Shan hills at 4000 feet.

Mountains of Northern and Southern India and the Malayan peninsula, China and Japan.

Berberis Wallichiana, *DC.*, var.? foliis integris venis immersis obsoletis; *Fl. Brit. Ind.* i. p. 110.—Shan hills at 4000 feet.

Nepal, Bootan, and Khasia hills.

CRUCIFERÆ.

Cardamine hirsuta, *Linn.*, var. sylvatica, *Link* (species); *Fl. Brit. Ind.* i. p. 138.—Shan hills plateau, 4000 feet.

Generally dispersed in temperate regions.

CAPPARIDACEÆ.

Cratæva lophosperma, *Kurz*; *Journ. Bot.* 1875, p. 195.—Shan hills.

Described from specimens collected in Assam.

Boscia variabilis, *Coll. et Hemsl.*, n. sp. (Plate I.)

Arbor 15–20-pedalis, tortuoso-ramosus, novellis puberulis. *Folia* simplicia, breviter petiolata, coriacea, anguste oblonga, 1–2½ poll. longa, apice rotundato- vel truncato-emarginata, basi cuneata, venis immersis inconspicuis. *Flores* circiter 6 lineas longi, in axillis foliorum superiorum densiuscule subcorymbosi, corymbis quam folia brevioribus; sepala 3–5, valvata, basi in tubum brevem sed distinctum connata, subcarnosa, lanceolato-oblonga, dorso longitudinaliter 1-costata; petala nulla; discus crassus, carnosus, cupulatus, tubum calycis vestiens; stamina 5–6, medio gynophori inserta, pistillum subæquantia; ovarium glabrum, longiuscule stipitatum, 1-loculare, placentis 2 circiter 5-ovuliferis. *Fructus* (immaturus tantum visus) globosus, pisiformis.—Capparis variabilis, *Wall. Cat.* n. 7004; Niebuhria variabilis, *Kurz*, *Forest Fl. Burma*, i. p. 59.

Common in the open forest-tracts about Meiktila.

Upper Burma.

This somewhat anomalous plant has been referred to both *Capparis* and *Niebuhria*, though neither Wallich nor Kurz's specimens bear either flowers or fruit. Some of the leaves of Wallich's specimens are as much as 4 inches long.

The definite stamens, inserted high up on the gynophore, and definite ovules bring it intermediate between *Mærua* and *Boscia*, and in habit and facies it strongly resembles several species of the latter genus; but these genera are not well defined.

DESCRIPTION OF PLATE I.

A branch of *Boscia variabilis*, Coll. et Hemsl., natural size.

Fig. 1, a leaf from a sterile branch, natural size; 2, a flower; and 3, vertical section of ovary. Enlarged.

Capparis burmanica, *Coll. et Hemsl.*, n. sp. (Plate II.)

Frutex inermis, ramulis floriferis rectis teretibus minute cinereo-puberulis. *Folia* (pauca superiora tantum visa) breviter petiolata, coriacea, elliptica vel fere orbicularia, absque petiolo 9–15 lineas longa, utrinque obtusissima vel rotundata, primum parce strigillosa cito glabrescentia, supra nitida, integerrima, venis immersis inconspicuis; petiolus teres, 2–3 lineas longus, pubescens. *Flores* 6–9 lineas diametro, racemoso-paniculati, ebracteati, paniculis terminalibus 6–9 poll. longis, pedicellis circiter 3 lineas longis calycibusque puberulis; sepala crassa, cymbiformia, margine pellucido; petala subcarnosa, ovato-lanceolata, obtusa, quam sepala paullo longiora; stamina indefinita ovarium glabrum, longe stipitatum, stamina paullo superans, 1-loculare, 3–5-ovulatum. *Fructus* deest.

Shwenoungbu, in the plains.

In foliage this resembles the Burmese *Capparis orbiculata*, Wall.; but it is characterized by the distinctly racemose-paniculate inflorescence.

DESCRIPTION OF PLATE II.

A branch of *Capparis burmanica*, Coll. et Hemsl., natural size.

Fig. 1, a sepal; 2, petals; 3, stamens; 4, stipitate pistil; 5, ovary, in vertical section. All enlarged.

Capparis flavicans, *Wall.*; *Fl. Brit. Ind.* i. p. 179; *Forest Fl. Burma*, i. p. 63.—Yemethen and other localities.

Also in Cochinchina.

The flowers of this species were unknown to Hooker and Thomson, who jointly elaborated the Capparideæ for the 'Flora of British India;' and Kurz, in his 'Forest Flora of Burma,' describes the petals, inadvertently doubtless, as densely woolly inside, instead of outside. The flowers are unisexual, at least those of the present collection—a condition that is exceedingly rare in this natural order. The stamens are usually eight in number.

Capparis glauca, *Wall.*; *Fl. Brit. Ind.* i. p. 180; *Forest Fl. Burma*, i. p. 65.—Meiktila.

The flowers of this species were previously unknown, and may be here described:—

Flores undique glaberrimi, parvi (circiter 4–5 lineas diametro), fasciculati, fasciculis multifloris sessilibus vel ramulis lateralibus

brevibus terminantibus, pedicellis glaberrimis filiformibus vel capillaribus 4–6 lineas longis sepalisque rufis; sepala orbicularia, concava, margine tenui pellucido; petala angusta, quam sepala vix longiora; stamina circiter 12–15; ovarium 1-loculare, circiter 8-ovulatum, cum gynophoro stamina vix æquans.

Var. **angustifolia,** *Coll. et Hemsl.*; ramulis lateralibus floriferis majus evolutis, foliis fere linearibus usque ad bipollicares.

Collected in the same locality as the typical form with obovate leaves less than an inch in length.

Capparis hastigera, *Hance in Journ. Bot.* 1868, p. 296, et 1879, p. 8; *Forbes et Hemsley in Journ. Linn. Soc.* xxiii. p. 51.—Capparis Swinhoii, *Hance in Journ. Bot.* 1868, p. 296.—Meiktila. A common bush on the dry plains.

South China.

This singular species was collected by Griffith at Malé, on the Irrawaddy; and is the "*Capparidea*" mentioned by him in his 'Journals of Travels,' i. p. 103; and Wallich collected it at Prome. It is the 6982 B of his catalogue. The flowering specimens now collected enable us to identify all these specimens with the Chinese species established by Hance. This species is exceedingly variable in the shape of the leaves, the hastate base sometimes disappearing altogether. Our specimens have very narrow leaves, reaching 4 inches in length.

Capparis xanthophylla, *Coll. et Hemsl.*, n. sp.

Frutex ramulis ultimis graciliusculis primum ferrugineo-furfuraceis demum glabrescentibus, aculeis brevissimis rigidis recurvis parce armatis. *Folia* distincte petiolata, rigide coriacea, crassa, siccitate flava, ovato-lanceolata, absque petiolo 3 poll. longa, subobtusa, basi cuneata, utrinque glaberrima, supra nitida, subtus pallidiora, opaca, costa supra impressa, subtus crassa, elevata, venis primariis lateralibus utrinque circiter 4 prominentibus et inter se anastomosantibus; petiolus semipollicaris, teres, crassus, rugulosus. *Flores* 12–15 lineas diametro, ferrugineo-furfuracei vel tomentosi, breviter pedicellati, secus ramulos laterales 3–12 poll. longos laxe fasciculati, pedicellis furfuraceis 3–12 lineas longis; sepala crassa, ovali-rotundata, cymbiformia, quam petala fere dimidio breviora; petala obovato-spathulata; stamina numerosissima, ovarium plus quam duplo superantia; ovarium glabrum, 1-loculare, placentis 3, multiovulatis. *Fructus* ignotus.

Dry plains near Yemethen.

In foliage this resembles *C. Heyneana*, Wall., differing widely in the size and arrangement of the flowers.

Capparis horrida, *Linn. f.*; *Fl. Brit. Ind.* i. p. 178; *Forest Fl. Burma*, i. p. 62.—Meiktila, and on the Shan hills plateau at 4000 feet.

Widely spread in tropical India and Malaya to the Philippine Islands.

Capparis olacifolia, *Hook. f. et T. Thoms.*; *Fl. Brit. Ind.* i. p. 178.—Shan hills, in various localities.

Eastern tropical India.

Capparis sepiaria, *Linn.*; *Fl. Brit. Ind.* i. p. 177; *Forest Fl. Burma*, i. p. 66.—Meiktila.

Dry places in India from the Punjab to Ceylon, and eastward to the Philippines.

Capparis tenera, *Dalz.*; *Fl. Brit. Ind.* i. p. 179.—Shan States at 5000 feet.

Southern India, Ceylon, Assam, and Tenasserim; also recorded from Yunnan.

The western specimens referred to this species have almost invariably solitary flowers, whereas in the eastern specimens they are fascicled.

Capparis viminea, *Hook. f. et T. Thoms.*; *Fl. Brit. Ind.* i. p. 179; syn. Capparis membranifolia, *Kurz, Forest Fl. Burma*, i. p. 61.—Shan hills terai at 2000 to 4000 feet.

Tropical valleys of Sikkim, Bhotan, Assam, and Tenasserim.

Authenticated specimens of Kurz's species are exactly like *C. viminea* from Mergui, collected by Griffith.

Violaceæ.

Viola biflora, *Linn.*; *Fl. Brit. Ind.* i. p. 182.—Shan hills at 6000 feet.

Scattered in temperate regions all around the northern hemisphere.

Viola Patrinii, *DC.*; *Fl. Brit. Ind.* i. p. 183.—Shan hills at 3000 to 4000 feet.

Nearly all over India, westward into Afghanistan, and in Siberia, Mandshuria, China, and Japan.

Viola serpens, *Wall.*; *Fl. Brit. Ind.* i. p. 184.—Shan hills at 4000 to 6000 feet.

Throughout India, in the mountainous regions, and extending to Java and China.

The Shan plant belongs to the variety named *V. canescens* by Wallich.

Bixineæ.

Flacourtia sapida, *Roxb.*; *Forest Fl. Burma*, i. p. 75.—Shan hills terai at 3000 feet.

The glabrous form. In the 'Flora of British India' this is treated as a variety of *F. Ramontchi*, L'Hérit., which is common throughout India and Malaya, wild or cultivated, and extends to Madagascar.

Pittosporeæ.

Pittosporum floribundum, *Wight et Arn.*; *Fl. Brit. Ind.* i. p. 199.—Shan hills at 4000 feet; also collected by Mr. Aplin.

Subtropical regions of India from Garhwal to Khasia and Mishmi, and in South India.

Polygaleæ.

Polygala crotalarioides, *Ham.*; *Fl. Brit. Ind.* i. p. 201.—Shan hills at 4000 feet.

North India, from Kashmir to Sikkim and the Khasia hills; also in Yunnan.

Var. ? **glabrescens**, *Coll. et Hemsl.*; racemis elongatis, floribus majoribus.—Shan hills at 4000 feet.

Polygala erioptera, *DC.*; *Fl. Brit. Ind.* i. p. 203.—Meiktila.

Widely spread in tropical Asia and Africa.

Polygala leptalea, *DC.*; *Fl. Brit. Ind.* i. p. 202.—Shan hills at 5000 feet.

Widely spread in the mountainous regions of India, and also found in North-eastern Australia.

Polygala sibirica, *Linn.*; *Fl. Brit. Ind.* i. p. 205.—Shan hills at 4000 feet.

North India, Siberia, Mandshuria, China, and Japan.

Polygala triphylla, *Ham.*; *Fl. Brit. Ind.* i. p. 201, var. glaucescens.—Shan hills at 3000 feet.

Northern and Central India, China, and the Malay peninsula.

Caryophylleæ.

Silene (§ Eusilene) burmanica, *Coll. et Hemsl.*, n. sp.

Herba perennis, erecta, 1–2-pedalis, habitu *Lychnidis dioicæ*, undique plus minusve aspere ferrugineo-pubescens, caulibus robustiusculis vix ramosis, internodiis folia æquantibus vel brevioribus. *Folia* radicalia non visa, caulina crassiuscula, asperula, sessilia, ovato-oblonga vel lanceolata, interdum obovata vel spathulata, 1–2 poll. longa, acuta vel abrupte breviterque acuminata, subtrinervia. *Flores* 5-meri, 9–10 lineas longi, pauci, dichotomo-cymosi, pedunculis brevibus glanduloso-hirsutis; calyx fere cylindricus, glanduloso-hirsutus, lobis brevibus ovato-oblongis obtusissimis vel rotundatis; petala glabra, calycem triente excedentes, inæqualiter quadrifida (lobis lateralibus minoribus interdum fere ad auriculas reductis), 2-squamata, lobis ovato-oblongis obtusis, squamis angustis elongatis; ovarium longiuscule stipitatum, glabrum, 1-loculare, stylis 3. *Capsula* ovoideo-oblonga, crustacea, nitida, semina (matura non visa) hippocrepiformia, rugosa.

Shan hills at 4000 feet.

Mr. Franchet describes sixteen new species of *Silene* from the Chinese province of Yunnan, only four of which are represented in the Kew Herbarium by authenticated specimens; and after a careful comparison with his descriptions, we have come to the conclusion that this is new. Nevertheless the genus is so numerous in species, exceedingly difficult to discriminate in a dried state, that the present species may yet be identified with a previously described one. From a note on one of the sheets of *S. burmanica* it appears that there is a specimen of the same species in the Calcutta Herbarium from Momyen, just within the western border of Yunnan.

Stellaria media, *Cyr.*; *Fl. Brit. Ind.* i. p. 230.—Shan hills 4000 to 6000 feet.

Arctic and North temperate regions generally, and widely colonized elsewhere.

Drymaria cordata, *Willd.*; *Fl. Brit. Ind.* i. p. 244.—Shan hills terai at 2000 feet.

Tropical and subtropical Asia, Africa, and America.

Polycarpæa corymbosa, *Lam.*; *Fl. Brit. Ind.* i. p. 245.—Meiktila.

Tropical and subtropical regions of Asia, Africa, America, and Australia.

Tamariscineæ.

Tamarix dioica, *Roxb.*; *Fl. Brit. Ind.* i. p. 249; *Forest Fl. Burma*, i. p. 83.—Shan states, common in beds of rivers.

India, ranging from Sindh and the Punjab to Assam, the Deccan, and Burma.

Hypericineæ.

Hypericum japonicum, *Thunb.*; *Fl. Brit. Ind.* i. p. 256.—Shan hills, in rice-fields at 4000 feet.

North-western India to Ceylon, China, and Japan, and southward to Australia and New Zealand.

Hypericum (§ Androsæmineæ) pachyphyllum, *Coll. et Hemsl.*, n. sp. (Plate III.)

Frutex vel herba lignosa, erecta, omnino glaberrima, caulibus rigidis rectis teretibus rufis, internodiis brevissimis. *Folia* sessilia, semiamplexicaulia, crasse coriacea, oblonga, 1–1¾ poll. longa, obtusa, subtus glauca, punctis inconspicuis conspersa, costa subtus elevata, venis immersis fere obsoletis. *Flores* 2–2¼ poll. diametro, in cymas densas terminales dispositi, brevissime pedicellati, cymis circiter 15-floris, bracteis foliis similibus 4–6 lineas longis instructis; sepala coriacea, foliis similia, leviter inæqualia, ovata, 4–6 lineas longa, obtusa; petala oblique obovata, pollicaria, epunctata; stamina numerosissima, libera vel sublibera; ovarium 5-loculare, stylis divergentibus recurvis stamina paullo excedentibus. *Capsula* ignota.

Shan hills, 4000 feet. Common throughout the Southern Shan States, especially in marshy localities.

This comes nearest to *H. Hookerianum*, Wight et Arn. (*H. oblongifolium*, Hook. Bot. Mag. t. 4949), differing in the denser habit, very thick oblong leaves, entire sepals, and free, or nearly free, stamens.

DESCRIPTION OF PLATE III.

A branch of *Hypericum pachyphyllum*, Coll. et Hemsl., natural size.

Fig. 1, a petal from a bud; 2, a bundle of stamens; 3, back and front views of anther; 4, pistil; 5, cross section of ovary. All enlarged.

TERNSTRŒMIACEÆ.

Anneslea fragrans, *Wall.*; *Fl. Brit. Ind.* i. p. 280; *Forest Fl. Burma*, i. p. 98.—Shan hills at 3000 to 5000 feet.

Martaban and Tenasserim.

Actinidia callosa, *Lindl.*; *Fl. Brit. Ind.* i. p. 286.—Shan hills at 5000 feet.

Temperate Himalaya, from Garhwal eastward, and extending to China and Japan.

Saurauja Roxburghii, *Wall.*; *Fl. Brit. Ind.* i. p. 287; *Forest Fl. Burma*, i p. 103.—Shan hills terai at 3000 feet.

Eastern India.

Schima Wallichii, *Choisy*; *Fl. Brit. Ind.* i. p. 289; *Forest Fl. Burma*, i. p. 106; syn. S. mollis, *Dyer*; *Fl. Brit. Ind.* i. p. 288. —Shan hills at 5000 feet; common on hills at 3000 to 4000 feet, *Aplin.*

Eastern India, Malay peninsula, and Sumatra.

DIPTEROCARPEÆ.

Shorea siamensis, *Miq.*; *Fl. Brit. Ind.* i. p. 304; syn. Pentacme siamensis, *Kurz*, *Forest Fl. Burma*, i. p. 119.—Shan hills terai at 2000 feet; one of the commonest trees in the Shan States, *Aplin.*

Malay peninsula.

Hopea? n. sp.; specimen floriferum tantum adest.—Shan hills terai at 2000 feet.

Flowers very sweet-scented and often worn by Shan girls in their hair.

This is very near *Hopea argentea*, Pierre, in foliage; but the leaves are yellowish beneath instead of silvery. Still, in the absence of fruit, we are not sure of the genus.

Malvaceæ.

Abutilon polyandrum, *Schlecht.*; *Fl. Brit. Ind.* i. p. 325.—Shan hills at 4000 feet.

North-west provinces of India to Ceylon, Burma, and Java, and also in tropical South Africa.

Urena repanda, *Roxb.*; *Fl. Brit. Ind.* i. p. 330.—Shan hills at 4000 feet; also collected by Mr. Aplin.

Widely spread in India, including the south.

Sida rhombifolia, *Linn.*; *Fl. Brit. Ind.* i. p. 323.—Shan hills at 4000 feet, *Manders.*

Tropical and subtropical regions of both hemispheres.

Pavonia glechomifolia, *A. Rich.*; *Fl. Brit. Ind.* i. p. 330.—Shan hills.

North-west provinces of India to Ceylon and Burma; also in tropical Africa and Arabia.

Hibiscus Abelmoschus, *Linn.*; *Fl. Brit. Ind.* i. p. 342.—Shan hills at 4400 feet, *Manders.*

Found throughout tropical India, and cultivated and more or less colonized in other tropical countries.

Kydia calycina, *Roxb.*; *Fl. Brit. Ind.* i. p. 348; *Forest Fl. Burma*, i. p. 124.—Shan hills, *Aplin.*

Common nearly throughout tropical and subtropical India.

Sterculiaceæ.

Sterculia versicolor, *Wall.*; *Fl. Brit. Ind.* i. p. 355; *Forest Fl. Burma*, i. p. 135.—No locality given.

Only known from Burma and the Malay peninsula.

Sterculia, n. sp.?—Lower Burma, *T. H. Aplin.*

There are only flowers of this distinct species.

Helicteres glabriuscula, *Wall.*; *Fl. Brit. Ind.* i. p. 366.—Shan hills at 4000 feet.

Restricted to Burma, so far as at present known.

The brief description in the place cited was drawn up from

imperfect material, and the Shan specimens enable us to amend and extend it here :—

Folia brevissime petiolata, oblonga, ovato-oblonga, oblongo-lanceolata, lanceolata vel interdum oblanceolato-oblonga, minute calloso-serrulata. *Flores* parvi, vix 6 lineas longi, axillares, geminati, pedunculo communi circiter 3 lineas longo, pedicellis brevissimis; calyx grosse stellato-hirsutus, rectus, æqualis, breviter 5-dentatus; petala æqualia, spathulata, apice rotundata, extus hirsuta, calycem triente vel dimidio excedentia, extus puberula, unguibus inæqualiter auriculato-appendiculatis; columna staminea basi hirsutula; ovarium longissime stipitatum, stylo simplice stamina paullo excedenti. *Capsula* recta, stellato-pubescens, 5-valvis, circiter semipollicaris.

Helicteres elongata, *Wall.*; *Fl. Brit. Ind.* i. p. 365; *Forest Fl. Burma*, i. p. 144.—Popah district.

Eastern India to Yunnan.

Pterospermum acerifolium, *Willd.*; *Fl. Brit. Ind.* i. p. 368; *Forest Fl. Burma*, i. p. 145.—Shan hills at 4000 feet.

North-west India to Concan, Chittagong, and Tenasserim; often cultivated. Found also in the Andaman islands.

Eriolæna Candollei, *Wall.*; *Fl. Brit. Ind.* i. p. 370; *Forest Fl. Burma*, i. p. 148.—Shan hills, in various localities from 3000 to 5000 feet.

Southern India and Malay peninsula.

TILIACEÆ.

Berrya Ammonilla, *Roxb.*; *Fl. Brit. Ind.* i. p. 383; *Forest Fl. Burma*, i. p. 155.—Shan hills, *Aplin.*

South India, Ceylon, Pegu, and Martaban.

Grewia (§ Eugrewia) elatostemoides, *Coll. et Hemsl.*, n. sp.

Arbor parva, ramulis floriferis graciliusculis, parce stellato-puberulis. *Folia* breviter petiolata, papyracea, oblique ovato-oblonga, 2–3½ poll. longa, vix acuta, basi sæpius rotundata, calloso-crenato-serrulata, dentibus sæpe alternatim minoribus, supra viridia, parce stellato-puberula, subtus albida, brevissime tomentosa, simul secus nervos stellato-pubescentia; petiolus teres, pubescens, 3–4 lineas longus. *Flores* circiter 6 lineas diametro

in cymas parvas breves axillares dispositi, pedicellis flores subæquantibus; sepala crassiuscula, oblongo-spathulata, obtusissima vel rotundata, margine incurva, extus albo-tomentosa, intus, ut videtur, colorata; petala minuta, crassa (cocta vesiculosa), apice bidentata, basi intus obscure foveolata; stamina numerosissima, sepalis fere dimidio breviora; ovarium dense albo-pilosum, 2-loculare? stylo crasso glabro stamina subæquanti. *Fructus* ignotus.

Shan hills at 3000 feet.

This does not very closely resemble any of the Asiatic species, most nearly perhaps *G. polygama*, Roxb., differing in the leaves being pale beneath, the very minute, bidentate petals, and other characters.

Grewia hirsuta, *Vahl*; *Fl. Brit. Ind.* i. p. 391; *Forest Fl. Burma*, i. p. 159.—Meiktila.

Southern India and throughout Burma.

Grewia lævigata, *Vahl*; *Fl. Brit. Ind.* i. p. 389; *Forest Fl. Burma*, i. p. 159.—Shan terai at 2000 feet.

Very widely spread in tropical Asia, and extending to tropical Africa and tropical Australia.

Grewia scabrophylla, *Roxb.*; *Fl. Brit. Ind.* i. p. 387; syn. G. sclerophylla, *Wall.*; *Forest Fl. Burma*, i. p. 162.—Shan hills at 3000 feet.

Tropical North India from Garhwal to Assam and Chittagong and Ava.

Kurz ('Forest Flora') records this species as Burmese on the authority of others, not having met with nor seen specimens himself.

Columbia floribunda, *Wall.*; *Fl. Brit. Ind.* i. p. 393; *Forest Fl. Burma*, i. p. 156.—Shan hills, *Aplin.*

Burma, Martaban.

Elæocarpus bracteatus, *Kurz, Forest Fl. Burma*, i. p. 165; *Fl. Brit. Ind.* i. p. 406.—Shan hills terai at 2000 feet.

Tenasserim and Martaban.

This species was not previously represented in the Kew Herbarium, and the specimen was so named at Calcutta.

Linaceæ.

Linum mysorense, *Heyne*; *Fl. Brit. Ind.* i. p. 411.—Shan hills at 4000 feet, in fields.

North-west India to Ceylon. Not previously recorded from Eastern India or Burma.

Reinwardtia trigyna, *Planch.*; *Fl. Brit. Ind.* i. p. 412.—Shan hills at 3000 feet, *Manders*.

Temperate and subtropical regions of India eastward into China.

Malpighiaceæ.

Hiptage candicans, *Hook. f. et T. Thoms.*; *Fl. Brit. Ind.* i. p. 419; *Forest Fl. Burma*, i. p. 174 (flor. descript.).—Shan hills from 1000 to 4000 feet; common in the dry forest.

Burma.

This is not a climber, as suggested in the 'Flora of British India,' but an erect shrub or small tree.

Aspidopterys Helferiana, *Kurz*, *Forest Fl. Burma*, i. p. 176. —Shan hills terai at 2000 feet.

Tenasserim.

Zygophylleæ.

Tribulus terrestris, *Linn.*; *Fl. Brit. Ind.* i. p. 423.—Meiktila.

Almost universally dispersed in tropical and subtropical regions.

Geraniaceæ.

Geranium nepalense, *Sweet*; *Fl. Brit. Ind.* i. p. 430.—Shan hills at 6000 feet.

Generally diffused in the mountains of India and Ceylon, and extending to Western China.

Averrhoa Carambola, *Linn.*; *Fl. Brit. Ind.* i. p. 439.—In a monastery garden; perhaps cultivated.

Cultivated throughout tropical India; native country uncertain, though probably America.

Impatiens arguta, *Hook. f. et T. Thoms.*; *Fl. Brit. Ind.* i. p. 470.—Shan hills at 4000 feet.

Sikkim, Khasia, and Western China.

Impatiens puberula, *DC.*; *Fl. Brit. Ind.* i. p. 470.—Shan hills at 4000 feet.

Mountains of Sikkim and Nepal.

Impatiens chinensis, *Linn.*; *Fl. Brit. Ind.* i. p. 444.—Shan hills at 4000 feet.

Very widely spread in the mountains of India, southward to Travancore, and extending to Eastern China.

Impatiens ecalcarata, *Coll. et Hemsl.*, n. sp. (Plate IV.)

Species, præter sepalum posticum galeatum, nec calcaratum, *I. chinensi* omnino simillima et vix distinguenda.

Shan hills at 4000 feet.

This so strongly resembles *I. chinensis* that one might suspect it to be an abnormal state of that species, were there not copious healthy specimens all exhibiting the same peculiarity in the shape of the posticous sepal. Indeed it may yet prove to be a modification of *I. chinensis*; but it would be none the less worth figuring.

DESCRIPTION OF PLATE IV.

A branch of *Impatiens ecalcarata*, Coll. et Hemsl., natural size.

Fig. 1, dorsal sepal; 2, a lateral sepal; 3, the coalescing anthers. All enlarged.

Rutaceæ.

Glycosmis pentaphylla, *Correa*; *Fl. Brit. Ind.* i. p. 499; *Forest Fl. Burma*, i. p. 186.—Meiktila.

Widely spread, and exceedingly variable, in India, Malaya, and tropical Australia.

Micromelum hirsutum, *Oliver*; *Fl. Brit. Ind.* i. p. 502; *Forest Fl. Burma*, i. p. 187.—Shan hills at 4000 feet.

Malay peninsula and archipelago.

Murraya exotica, *Linn.*; *Fl. Brit. Ind.* i. p. 502; *Forest Fl. Burma*, i. p. 190.—Shan hills terai at 2000 feet.

Tropical Asia, Australia, and Polynesia.

Murraya Kœnigii, *Spreng.*; *Fl. Brit. Ind.* i. p. 503; *Forest Fl. Burma*, i. p. 190.—Shan hills terai at 2000 feet.

Garhwal to Ceylon, Assam, and Tenasserim.

SIMARUBEÆ.

Harrisonia Bennettii, *Planch.*; *Fl. Brit. Ind.* i. p. 519; *Forest Fl. Burma*, i. p. 203.—Meiktila.

Malay peninsula and archipelago to South China and the Philippines.

OCHNACEÆ.

Ochna squarrosa, *Linn.*; *Fl. Brit. Ind.* i. p 523; *Forest Fl. Burma*, i. p. 205.—Shan hills.

South India and Ceylon, and Silhet to Tenasserim.

BURSERACEÆ.

Garuga pinnata, *Roxb.*; *Fl. Brit. Ind.* i. p. 528; *Forest Fl. Burma*, i. p. 207.—Shan hills terai at 3000 feet.

Throughout India and Malaya.

MELIACEÆ.

Melia Azedarach, *Linn.*; *Fl. Brit. Ind.* i. p. 544; *Forest Fl. Burma*, i. p. 212.—Shan hills at 3000 feet.

Persia, subtropical North India and China, and widely cultivated.

Cipadessa fruticosa, *Blume*; *Fl. Brit. Ind.* i. p. 545; *Forest Fl. Burma*, i. p. 214.—Shan hills at 3000 feet.

South India, Ceylon, Burma, and Java.

Walsura, n. sp. ?—Shan hills terai at 3000 feet.

A flowering specimen only was collected, and this is hardly sufficient to determine the genus with certainty.

Chickrassia tabularis, *Adr. Juss.*; *Fl. Brit. Ind.* i. p. 568; *Forest Fl. Burma*, i. p. 227.—Shan hills, *Aplin*.

South India, Ceylon, Malaya, and Andaman islands.

OLACINEÆ.

Olax scandens, *Roxb.*; *Fl. Brit. Ind.* i. p. 575; *Forest Fl. Burma*, i. p. 233.—Shan hills terai.

Generally spread in tropical India, Burma, and Malay peninsula, and extending to Java.

Cansjera Rheedii, *J. F. Gmel.*; *Fl. Brit. Ind.* i. p. 582; *Forest Fl. Burma*, i. p. 237.—Meiktila.

Generally spread in tropical India and Malaya and extending to South China and North Australia.

Opilia amentacea, *Roxb.*; *Fl. Brit. Ind.* i. p. 583; *Forest Fl. Burma*, i. p. 238.—Shan hills terai at 3000 feet.

Widely spread in the tropics of the Old World.

CELASTRINEÆ.

Euonymus glaber, *Roxb.*; *Fl. Brit. Ind.* i. p. 609; *Forest Fl. Burma*, i. p. 249.—Shan hills terai at 2000 feet.

Eastern Bengal and Muneypore southward to Tenasserim.

Euonymus grandiflorus, *Wall.*; *Fl. Brit. Ind.* i. p. 608.—Shan hills at 4000 feet.

North India, from Kumaon to Khasia.

Celastrus paniculatus, *Willd.*; *Fl. Brit. Ind.* i. p. 617; *Forest Fl. Burma*, i. p. 252.—Shan hills at 5000 feet.

Tropical and subtropical regions of India and Malaya generally.

Gymnosporia ovata, *Lawson*, var.; *Fl. Brit. Ind.* i. p. 619.—Shan hills plateau, 4000 feet.

This does not exactly correspond to the Nilghiri specimens of *G. ovata*, the flowers being somewhat larger and the fruit smaller; but we can discover no tangible characters to separate it specifically.

Gymnosporia pallida, *Coll. et Hemsl.*, n. sp.

Frutex circiter 3-pedalis, inermis vel paucispinosus, undique glaberrimus, ramulis floriferis crassiusculis cortice foliisque pallidis. *Folia* breviter petiolata, subcoriacea, ovato-oblonga vel obovata, 3–5 poll. longa, apice obtusa vel interdum rotundata, basi cuneata, crenulata, venis reticulatis sat conspicuis. *Flores* 3–4 lineas diametro, dichotome cymosi, cymis densis, rigidiusculis, 1–1½ poll. longis, pedicellis brevibus sursum incrassatis; sepala crassa, persistentia, orbicularia, ciliolata, petalis dimidio minora; petala glabra, orbiculari-oblonga; ovarium 3-loculare. *Capsula* 3-locularis, alte 3-lobata, lævis, 6–8 lineas diametro; semina ignota.

Shan hills at 3000 to 4000 feet.

In foliage and general appearance this approaches *G. acuminata*, Hook. f.; but that always dries of a dark colour and the ovary and capsule are 2-celled.

RHAMNACEÆ.

Ventilago calyculata, *Tulasne*; *Fl. Brit. Ind.* i. p. 631; *Forest Fl. Burma*, i. p. 262.—Meiktila.

Almost throughout tropical India and Malaya.

Zizyphus Œnoplia, *Mill.*; *Fl. Brit. Ind.* i. p. 634; *Forest Fl. Burma*, i. p. 266.—Meiktila.

Tropical Asia and Australia.

Zizyphus incurva, *Roxb.*; *Fl. Brit. Ind.* i. p. 635.—Shan hills at 4000 to 5000 feet; also collected by Mr. Aplin.

Nepal, Bhotan, South India, and Ceylon.

Zizyphus rugosa, *Lam.*; *Fl. Brit. Ind.* i. p. 636; *Forest Fl. Burma*, i. p. 265.—Shan hills at 4000 feet; also collected by Mr. Aplin.

Tropical India, Burma and Tenasserim.

Rhamnus virgatus, *Roxb.*?; *Lawson in Fl. Brit. Ind.* i. p. 604, sub *R. dahurico*.—Shan hills at 4000 feet.

In our opinion more than one species is included in the 'Flora of British India' under the name of *R. dahuricus*, Pall., but the species are very difficult of limitation.

Berchemia flavescens, *Wall.*; *Fl. Brit. Ind.* i. p. 637; syn. B. polyphylla, *Wall. loc. cit.* p. 638.—Shan hills at 4500 feet.

Nepal, Sikkim, Burma, and China.

Some of the forms of *B. lineata*, DC., approach this very closely.

AMPELIDEÆ.

Vitis discolor, *Dalz.*; *Fl. Brit. Ind.* i. p. 647; *Forest Fl. Burma*, i. p. 271.—Upper Burma.

Sikkim to Khasia, Chittagong, Tenasserim and Java, and Concan in South India.

Vitis adnata, *Wall.*; *Fl. Brit. Ind.* i. p. 649.—Shan hills plateau at 4000 feet.

Generally diffused in tropical India and Malaya.

Vitis lanata, *Roxb.*, var. **glabra,** *Laws.*; *Fl. Brit. Ind.* i. p. 651. —Shan hills plateau at 4000 feet.

The typical form is very widely spread in India; and this variety, if variety it be, is recorded from Garhwal and the Khasia mountains; and it has more recently been collected in Muneypore by Dr. Watt, who, perhaps correctly, regards it as a distinct species.

Vitis repens, *Wight et Arnott*; *Fl. Brit. Ind.* i. p. 646.—Shan hills at 4000 feet.

Very widely spread in tropical India and Malaya.

Vitis heterophylla, *Thunb.*?; *DC. Monogr. Phanerog.* v. 2, p. 455, sub *Ampelopside.*—Shan hills at 5000 feet.

This species is widely spread in China, Mongolia, Mandshuria, and Japan; and it is very variable in the shape of the leaves.

Vitis (§ Tetrastigma) pycnantha, *Coll. et Hemsl.*, n. sp.

Frutex præter flores fere undique glaber, ramulis floriferis crassiusculis sulcatis vel striatis. *Cirrhi* simplices. *Folia* trifoliolata, breviter petiolata (petiolus 3–6 lineas longus); foliola brevissime petiolulata, crassa, subcarnosa, inæqualia, obovato-oblonga, lateralia leviter obliqua, 2–3½ poll. longa, apice rotundata, basi cuneata vel plus minusve rotundata, remote obscureque calloso-crenata, venis primariis lateralibus utrinque 5–6 subtus inconspicuis. *Flores* minuti, densissime cymoso-glomerati, cymis axillaribus subsessilibus puberulis circiter 1 poll. diametro; petala hirsuta, persistentia, crassa, lata, apice cucullata; stigma alte 4-lobatum, lobis arcte recurvis. *Fructus* ignotus.

Yemethen.

A very distinct species, exhibiting no close resemblance to any species with which we are acquainted.

Vitis (§ Tetrastigma ?) megabotrya, *Coll. et Hemsl.*, n. sp.

Frutex alte scandens, glaber vel glabrescens, ramulis floriferis crassis ut in *V. vinifera*. *Cirrhi* non visi. *Folia* trifoliolata (unicum delapsum tantum visum) longe petiolata; foliola (iis *V. lanceolariæ* et *V. planicaulis* simillima) breviter petiolulata, crassa, subcarnosa, subæqualia, oblongo-lanceolata, 7–9 poll. longa, obtusa, grosse calloso-crenata, venis primariis lateralibus utrinque 10–12 subtus leviter elevatis. *Flores*, ut videtur, dioici (♂ tantum visi), laxissime cymosi, simul brevissime pedi-

cellati, circiter 2 lineas longi, cymis 8 poll. diametro; petala hirsuta, per anthesin persistentia, crassa, lata, insigniter galeata, erecta; stamina quam petala breviora.

Shan hills terai at 3000 feet.

The leaflets resemble those of the quinquefoliate *V. planicaulis*, Hook. f., and *V. lanceolaria*, Roxb.; but the large loose inflorescence is very different.

Vitis (§ Tetrastigma) burmanica, *Coll. et Hemsl.*, n. sp.

Frutex scandens, hirsutus, ramulis floriferis graciliusculis. *Cirrhi* non visi. *Folia* distincte petiolata (petiolus 6–12 lineas longus), trifoliolata; foliola subsessilia, crassiuscula, lanceolata, ovato-lanceolata vel interdum elliptica (lateralia leviter obliqua), 1–1½ poll. longa, acuta vel rotundata, apiculata, pauci calloso denticulata; stipulæ latæ, persistentes. *Flores* minimi, in cymas parvas densas (vix 1 poll. diametro) pseudoterminales dispositi, pedicellis brevissimis; petala glabra, apice leviter incurva; stigma breviter 4-lobatum, lobis depressis. *Bacca* immatura glabra, circiter 2 lineas diametro.

Shan hills plateau at 4000 feet.

In general appearance this resembles *V. mollis*, Wall., which has 5-foliolate leaves.

Vitis (§ Tetrastigma) Apliniana, *Coll. et Hemsl.*, n. sp.

Frutex scandens, præter flores fere omnino glaber, ramulis floriferis crassiusculis. *Cirrhi* non visi. *Folia* longe petiolata (petiolis foliola æquantibus), pedatim 5-foliolata; foliola inæqualia, distincte petiolulata, coriacea vel subcarnosa, lanceolata vel oblanceolata, 2½–4 poll. longa, obtusa, basi cuneata, supra medium remote crenato-dentata, venis immersis inconspicuis. *Flores* circiter 3 lineas diametro, umbellatim cymosi, cymis paniculatis longe graciliterque pedunculatis, paniculis quam folia brevioribus, pedicellis fere filiformibus flores æquantibus vel longioribus petala crassiuscula, oblonga, cucullata, puberula; stigma 4-lobatum, lobis crassis. *Fructus* ignotus.

Shan hills terai at 2000 feet.

This most nearly resembles *V. dubia*, Laws., in foliage, but the inflorescence is characteristic.

Named after Mr. T. H. Aplin, of the Government Forest Department in Burma.

Sapindaceæ.

Cardiospermum Corindum, *Linn.*; *DC. Prodr.* i. p. 602; syn. C. canescens, *Wall.*; *Fl. Brit. Ind.* i. p. 670.—Meiktila.

Southern India and Burma; also in Abyssinia.

Schleichera trijuga, *Willd.*; *Fl. Brit. Ind.* i. p. 681; *Forest Fl. Burma*, i. p. 289.—Shan hills at 5000 feet.

Widely spread in India and Malaya.

Æsculus punduana, *Wall.*; *Fl. Brit. Ind.* i. p. 675; syn. Æ. assamica, *Griff.*; *Forest Fl. Burma*, i. p. 286.—Shan hills at 4000 feet.

Sikkim and Khasia, and southward to Tenasserim and Siam.

Turpinia pomifera, *DC.*; *Fl. Brit. Ind.* i. p. 698; *Forest Fl. Burma*, i. p. 292.—Shan hills terai at 3000 feet.

Tropical and subtropical Asia, from Southern India and Ceylon to Khasia, Malaya, and Eastern China.

Anacardiaceæ.

Rhus semialata, *Murr.*; *Fl. Brit. Ind.* ii. p. 10; *Forest Fl. Burma*, i. p. 319, sub *R. javanica*.—Shan hills plateau at 5000 feet.

Himalaya and Khasia mountains to the Malay Archipelago.

Rhus paniculata, *Wall.*; *Fl. Brit. Ind.* ii. p. 10; *Forest Fl. Burma*, i. p. 319.—Meiktila; and in the Shan hills, *Aplin*.

Eastern India, Burma, and Yunnan.

Melanorrhœa usitata, *Wall.*; *Fl. Brit. Ind.* ii. p. 25; *Forest Fl. Burma*, i. p. 318.—Koni at 4000 feet; also collected by Aplin.

Muneypore to Tenasserim.

This is very variable in the shape of the leaves.

Odina Wodier, *Roxb.*; *Fl. Brit. Ind.* ii. p. 29; *Forest Fl. Burma*, i. p. 321.—Shan hills plateau at 4000 feet.

Throughout tropical India and Malaya.

Pistacia coccinea, *Coll. et Hemsl.*, n. sp.

Arbor parva, ramulis fructiferis graciliusculis glabris, cortice albido crebre lenticellato. *Folia* paripinnata, breviter petiolata,

4–6 poll. longa, rhachide haud alata angustissima leviter canaliculata; foliola 5–6-juga, subsessilia, alterna, vel superiora subopposita, glaberrima, coriacea, oblongo-lanceolata, 1–1½ longa, truncato-retusa, simul apiculata, supra nitida, costa impressa, subtus pallidiora, venis primariis lateralibus utrinque circiter 12 sat conspicuis. *Flores* spicato-paniculati, paniculis parvis quam folia dimidio brevioribus, ramulis gracillimis . . . . *Drupa* compressa, latior quam longa, circiter 3 lineas lata.

Shan hills at 4000 feet.

This must be closely allied to *P. weinmannifolia*, Poisson (Bull. Soc. Bot. France, xxxiii. p. 467), from Yunnan, which we have not seen. It differs from that, according to the description, in being glabrous and in the larger dark green apiculate leaves.

It also resembles *P. Lentiscus*, Linn., differing in the rhachis of the leaf not being winged, and in the smaller duller-coloured fruit.

CORIARIEÆ.

Coriaria nepalensis, *Wall.*; *Fl. Brit. Ind.* ii. p. 441.—Shan hills plateau at 4000 feet.

North India and Western China.

LEGUMINOSÆ: *Papilionaceæ.*

Crotalaria alata, *Ham.*; *Fl. Brit. Ind.* ii. p. 69.—Shan hills at 5000 feet.

Kumaon eastward to Khasia and Mishmi, and southward to Java.

Our specimen has the broad stipular wing of *C. alata*, Ham., and the short-stalked pod of the South-Indian and Ceylon *C. rubiginosa*, Willd.; and we can find no character to distinguish them from each other as species.

Crotalaria (§ Calycinæ) perpusilla, *Coll. et Hemsl.*, n. sp. (Plate V.)

Herba annua? procumbens vel prostrata, ramulis gracilibus parce pilosis dense foliatis 2–3 poll. longis. *Folia* simplicia, brevissime petiolata, papyracea, patentia, ovali-rotundata, 3–4 lineas longa, minute apiculata, utrinque longissime parceque albo-strigilloso-pilosa, simul minute punctata; stipulæ obsoletæ. *Flores* purpurei, circiter 6 lineas longi, 2–5 ad apices ramulorum pro-

ducti, breviter pedicellati ; calyx dense villosus, bilabiatus, quam petala paullo brevior, segmentis lanceolatis vix acutis 2 superioribus latioribus longioribus ; vexillum fere orbiculatum, extus medio apicis parce barbatum, intus basi bicallosum, ungue brevi recto puberulo ; alæ obovatæ ; carina leviter incurva, brevissime unguiculata, margine superiore ciliata ; stamina glabra ; ovarium glabrum, sessile, circiter 14-ovulatum, stylo incurvo glabro stamina superanti. *Legumen* (immaturum tantum visum) 1–2-spermum.

Shan hills at 4000 feet.

Allied to *C. pusilla*, Heyne, and *C. hirta*, Willd., but at once distinguishable by its more prostrate habit and rounded leaves.

DESCRIPTION OF PLATE V.

Portion of a plant of *Crotalaria perpusilla*, Coll. et Hemsl., nat. size.

Fig 1, portion of a leaf ; 2, a flower, with petals and stamens removed ; 3, keel ; 4, a wing ; 5, standard ; 6, stamens ; 7, pistil, with the ovary laid open ; 8, very young pod. All the dissections more or less enlarged.

Crotalaria albida, *Heyne* ; *Fl. Brit. Ind.* ii. p. 71.—Shan hills at 3000 feet.

Throughout India, Malaya, and China.

Crotalaria (§ **Calycinæ**) **burmanica,** *Coll. et Hemsl.*, n. sp.

Herba annua vel perennis, undique pilis longis vestita, caulibus erectis strictis, ut videtur, simplicibus appresse argenteo-pilosis. *Folia* simplicia, brevissime petiolata, papyracea, erecta vel caule appressa, anguste lanceolato-oblonga, oblanceolata vel superiora fere linearia, 1–1½ poll. longa, vix acuta, utrinque, sed præcipue subtus, pilis longis appressis albidis parce vestita ; stipulæ minutæ, subulatæ. *Flores* circiter 9 lineas longi, in racemos erectos compactos terminales dispositi, pedicellis brevissimis, bracteis angustissimis persistentibus flores plus quam dimidio brevioribus ; calyx longe denseque villosus, corollam fere æquans, subbilabiatus, segmentis vix acutis, 2 superioribus latioribus ; vexillum fere orbiculare, extus secus plicam apicem versus hirsutum, intus basin versus biauriculatum, ungue brevi lato conspicue bicalloso ; alæ obovato-oblongæ, breviter unguiculatæ, vexillum fere æquantes, ungue torto ; carina brevior, incurva, apice lata, retusa vel breviter bilobata, lobis rotundatis ; ovarium

sessile, oblongum, glabrum, multiovulatum, stylo glabro stamina paullo excedente. *Legumen* ignotum.

Shan hills at 4000 feet.

In technical characters allied to *C. sessiliflora*, Linn., differing in its remarkably stiff habit, appressed leaves, silvery tomentum, and rather more loosely racemose spreading flowers.

Crotalaria neriifolia, *Wall.*; *Fl. Brit. Ind.* ii. p. 74.—Shan hills at 3000 to 4000 feet.

Previously only recorded from mount Taong Dong, in Burma. The pod of this handsome species is still unknown, and the species was not previously represented in the Kew Herbarium.

Crotalaria retusa, *Linn.*; *Fl. Brit. Ind.* ii. p. 75.—Meiktila.

General in tropical Asia and North Australia; also common in tropical Africa and America, where, however, it is believed to be a colonist.

Crotalaria Kurzii, *Baker*; *Fl. Brit. Ind.* ii. p. 75.—Shan hills at 4000 feet.

Pegu.

Indigofera trita, *Linn. fil.*; *Fl. Brit. Ind.* ii. p. 96.—Meiktila.

Tropical Asia, Africa, and Australia.

Indigofera endecaphylla, *Jacq.*; *Fl. Brit. Ind.* ii. p. 98.—Shan hills at 3500 feet.

Tropical India, Malaya, and South China, and tropical and South Africa.

Indigofera hirsuta, *Linn.*; *Fl. Brit. Ind.* ii. p. 98.—Meiktila.

Tropical Asia, Africa, America, and Australia.

Indigofera pulchella, *Roxb.*; *Fl. Brit. Ind.* ii. p. 101; *Forest Fl. Burma*, i. p. 361.—Shan hills at 4000 feet.

North India and Burma, southward to Martaban.

Indigofera Dosua, *Ham.*; *Fl. Brit. Ind.* ii. p. 102.—Shan hills at 4000 feet.

North India, from Simla eastward to Assam.

Indigofera caloneura, *Kurz, Forest Fl. Burma*, i. p. 360; *Fl. Brit. Ind.* ii. p. 93.—Shan hills at 4000 feet.

Pegu.

Psoralea corylifolia, *Linn.*; *Fl. Brit. Ind.* ii. p. 103.—Meiktila.

Widely spread in India southward to Ceylon and westward to Arabia.

Millettia pendula, *Benth.*; *Fl. Brit. Ind.* ii. p. 105; syn. M. leucantha, *Kurz, Forest Fl. Burma*, i. p. 356.—Shan hills terai at 2000 feet.

Prome and Pegu.

Millettia Brandisiana, *Kurz, Forest Fl. Burma*, i. p. 355; *Fl. Brit. Ind.* ii. p. 108.—Near Yemethen; and in the Shan hills, *Aplin*.

Burma, near Yomah and Prome.

Millettia Dorwardi, *Coll. et Hemsl.*, n. sp.

Species *M. cinerea* simillima et forsitan ejus varietas, differt floribus majoribus (alabastris fere rectis), calycis dentibus 3 inferioribus rotundatis, vexillo fere orbiculari distincte biauriculato.

Arbor erecta, ramulis floriferis puberulis crassiusculis. *Folia* 5-foliolata, longiuscule petiolata, cito glabrescentia; foliola opposita, breviter petiolulata, inæqualia, coriacea, ovato-oblonga, elliptica, vel obovato-oblonga, 2–4½ poll. longa, obtusissima vel rotundata, primum utrinque secus costam plus minus appresse hirsutula, utrinque minute reticulato-venosa, subtus pallidiora, petiolo graciliusculo petiolulisque puberulis; stipulæ cito deciduæ non visæ; stipellæ subulatæ, persistentes. *Flores* sericeo-tomentosi, circiter 9 lineas longi, dense racemoso-paniculati (paniculis terminalibus brevissime pedunculatis circiter 4 poll. longis et 3 poll. latis) breviter pedicellati, sub calyce bibracteolati; calyx brevis, latus, obscure bilabiatus, labio superiore late truncato simul leviter retuso, labio inferiore late breviterque trilobato, lobis rotundatis; petala striata; vexillum extus dense sericeo-tomentosum, fere orbiculatum, breviter unguiculatum, biauriculatum; alæ angustæ, longiuscule unguiculatæ, inæqualiter biauriculatæ, carina triente breviores; carina fere recta, biauri-

culata, vexillum æquans; stamina diadelphia; ovarium sessile, dense villosum, circiter 8–10-ovulatum. *Legumen* ignotum.

Shan hills at 4000 to 5000 feet.

Named after Major A. Dorward, R.E., who kindly assisted me in many ways collecting plants, including the present one.

In many respects this so strongly resembles *M. cinerea*, Benth., that we hesitated giving it specific rank. The genus is largely developed in Burma, and several of the species are imperfectly known. Kurz describes eighteen species in his 'Forest Flora of British Burma,' most of which are endemic, or at least do not extend westward into India.

Millettia macrostachya, *Coll. et Hemsl.*, n. sp.

Frutex vel *arbor* parva, novellis plus minusve pubescentibus vel fere omnino glabris, ramulis floriferis crassiusculis subangulatis. *Folia* ampla, superiora 12–18 poll. longa, 9–11-foliolata, distincte petiolata, rhachide parce pubescenti vel glabrescenti, striata, supra canaliculata; foliola opposita, breviter petiolulata, pallida, papyracea, ovato-oblonga, deorsum minora, 2–6 poll. longa, obtuse acuminata, supra glabra, subtus pubescentia vel glabra, pallidiora, venis primariis lateralibus utrinque circiter 10 conspicuis. *Flores* pulchre rosei, 9–12 lineas longi, racemosi, fasciculati, extus plus minusve puberuli, breviter pedicellati, racemis axillaribus 12–20 poll. longis; calyx latus, subbilabiatus, dentibus 2 superioribus fere omnino connatis labium deltoideum formantibus, dentibus 3 inferioribus paullo brevioribus subæqualibus deltoideis subacutis; petala fere æquilonga; vexillum rotundatum, exauriculatum; alæ basi semihastatæ; carina semihastata, recta; stamina diadelphia; ovarium sessile, pubescens, pluriovulatum. *Legumen* ignotum.

Shan hills, 2000 to 4000 feet.

In foliage this resembles *M. pachycarpa*, Benth., which, however, has a much-branched inflorescence.

Millettia multiflora, *Coll. et Hemsl.*, n. sp.

Arbor novellis ferrugineo-tomentosis. *Folia* circiter 6 poll. longa, sæpius 11-foliolata, graciliter petiolata, stipulis parvis deciduis; foliola opposita, breviter petiolulata, ovato-oblonga, obovato-oblonga, elliptica vel interdum rotundata, 1–1½ poll. longa, obtusa, sæpius brevissime acuminata, interdum leviter retusa, minute stri-

gilloso-hirsuta, demum fere glabrescentia, stipellis minutis subulatis. *Flores* 8–9 lineas longi, racemoso-fasciculati, extus sericeo-hirsuti, brevissime pedicellati, racemis numerosis axillaribus vel subterminalibus 6–8 poll. longis graciliusculis; calyx latus, ut videtur, coloratus, obscure bilabiatus, labio superiore breviore brevissime bidentato, labio inferiore fere æqualiter 3-lobato, lobis deltoideis subacutis; petala fere æquilonga; vexillum orbiculatum, longiuscule unguiculatum, basi obscure biauriculatum; alæ oblongæ, vix obliquæ; carina fere recta; stamina diadelphia; ovarium sessile, dense hirsutum, pluriovulatum. *Legumen* non visum.

Meiktila. Common in the dry forests.

Near *M. Brandisiana*, Kurz, which has more numerous lanceolate-oblong leaflets and a glabrous calyx.

Millettia, sp. n.?—Shan hills terai at 3000 feet.

A specimen in young fruit with foliage remarkably like that of *M. glaucescens*, Kurz, but the tomentose pod is totally different. It is most likely an undescribed species, of which further material is necessary to draw up a satisfactory description.

Gueldenstaedtia multiflora, *Bunge*; *Fl. Brit. Ind.* ii. p. 118.—Shan hills plateau at 4500 feet.

Central and Northern provinces of China, and it has also been collected in the Himalaya, though the locality is unknown.

Zornia diphylla, *Pers.*; *Fl. Brit. Ind.* ii. p. 147.—Meiktila.

Diffused throughout the tropics.

Desmodium umbellatum, *DC.*; *Fl. Brit. Ind.* ii. p. 161; *Forest Fl. Burma*, i. p. 385.—Meiktila.

Tropical India, Malaya, South China, Polynesia, and the Mascarene islands.

Desmodium biarticulatum, *Benth.*; *Fl. Brit. Ind.* ii. p. 163.—Popah.

Tropical India, Malaya, and N. Australia.

Desmodium triquetrum, *DC.*; *Fl. Brit. Ind.* ii. p. 163; *Forest Fl. Burma*, i. p. 384.—Shan hills at 3000 feet.

Widely spread in tropical Asia eastward to China and the Philippine islands, and in the Mascarene islands.

Desmodium oblongum, *Wall.*; *Fl. Brit. Ind.* ii. p. 166.—Shan hills plateau at 4000 feet.

Previously only known to us from the Laong-dong mountains in Burma.

The present specimen in very young flower differs from the type in being nearly glabrous, and in the unbranched inflorescence.

Desmodium floribundum, *G. Don*; *Fl. Brit. Ind.* ii. p. 167.—Shan hills terai at 2000 feet.

North India, from the Punjab to Khasia.

Desmodium latifolium, *DC.*; *Fl. Brit. Ind.* ii. p. 168; *Forest Fl. Burma*, i. p. 385.—Shan hills terai.

Tropical Asia, eastward to the Philippine islands, and in tropical Africa.

Uraria lagopoides, *DC.*, var. racemis elongatis distincte pedunculatis gracilioribus; *Fl. Brit. Ind.* ii. p. 156.—Shan hills at 4000 feet.

Tropical Asia, eastward to South China, Polynesia and Australia.

Uraria hamosa, *Wall.*; *Fl. Brit. Ind.* ii. p. 156.—Meiktila.

India and Malaya, eastward to Central China.

NEOCOLLETIA, *Hemsl.*

(*Hedysarearum* novum genus *Phylacium* proximum.)

Calyx tubulosus, 15-nervis, subæqualiter 5-lobatus, lobis brevissimis rotundatis. *Vexillum* suborbiculatum, inappendiculatum; alæ liberæ, oblongæ, calcaratæ; carina recta, obtusissima. *Stamen* vexillare liberum, cætera connata; antheræ uniformes. *Ovarium* sessile, uniovulatum; stylus inflexus. *Legumen* ignotum.—*Herba* gracillima, longe repens, radicans. *Folia* pinnatim trifoliolata; stipulæ rigidæ, striatæ, persistentes. *Flores* minimi, ad axillas foliorum solitarii, vel 2–3 aggregati, longe graciliterque pedunculati, juxta calycem bibracteolati; pedunculus bractea insigni stipitata sellæformi complicata calycem amplectenti instructus.

In habit this genus more nearly resembles some of the slender *Phaseoleæ* than any of the *Hedysareæ*, though in floral characters it is near *Phylacium*.

Neocollettia gracilis, *Hemsl.*, n. sp. (Plate VI.)

Herba perennis? caulibus repentibus elongatis fere filiformibus plus minusve retrorsum strigillosis. *Folia* trifoliolata, cum petiolo gracili circiter 2–2½ poll. longa; foliola petiolulata (terminale longiuscule), papyracea, vel fere membranacea, pallida, obcordata, 8–10 lineas longa, supra glabra, subtus albo-strigillosa; stipulæ parvæ, rigidæ, striatæ, persistentes; stipellæ minutæ, subulatæ. *Flores* 2–3 lineas longi, pedunculis quam folia brevioribus densissime retrorsum albo-strigillosis, bractea bracteolisque subtus strigillosis; calyx extus strigillosus; petala longiuscule unguiculata; vexillum retusum; alæ oblongæ, calcaratæ simul margine inferiore 1-dentatæ; ovarium glabrum.

Posobio in the plains.

DESCRIPTION OF PLATE VI.

A portion of a plant of *Neocolletia gracilis*, Hemsl., natural size.

Fig. 1, portion of a leaflet; 2, a stipule; 3, a flower; 4, bract spread open; 5, calyx laid open; 6, standard; 7, one of the wings; 8, one of the keel-petals; 9, stamens; 10, pistil, the ovary in section showing the solitary ovule. All enlarged.

Phylacium majus, *Coll. et Hemsl.*, n. sp. (Plate VII.)

Herba volubilis, novellis appresse hirsutis, ramis floriferis teretibus graciliusculis lignescentibus. *Folia* pinnatim trifoliolata, longe petiolata (cum petiolo usque ad 6 poll. longa); foliola distincte petiolulata, papyracea, ovali-oblonga, 2–3½ poll. longa (lateralia minora), obtusissima, interdum obscure retusa, basi brevissime cordata, supra glabra, reticulato-venosa, subtus dense aureo-strigillosa, stipulis stipellisque parvis fere linearibus acutissimis persistentibus. *Flores* 6–7 lineas longi in racemos axillares 4–6 poll. longos fasciculatim dispositi (racemis interdum ramulis 1–2 lateralibus instructis), breviter pedicellati (pedicellis retrorsum strigillosis), florum fasciculis bractea ampla cucullato-complicata subtendis; bracteæ auctæ, 1–1½ poll. longæ, extus glabræ, intus strigillosæ, demum scariosæ; calyx extus strigillosus, subbilabiatus, labio superiore subintegro deltoideo-rotundato, labio inferiore trilobato, lobis ovato-rotundatis acutis late imbricatis; petala glabra, subæquilonga; vexillum

latum, breviter unguiculatum, basi insigniter biauriculatum; alæ oblongæ, longissime calcaratæ; carina fere recta, obtusa, breviter bicalcarata; stamina distincte diadelphia, stamen vexillare vexillo basi adnatum; ovarium breviter stipitatum, disco annulari brevi cinctum, secus suturam superiorem puberulum, 1-ovulatum. *Legumen* deest.

Shan hills at 3000 feet.

DESCRIPTION OF PLATE VII.

A branch of *Phylacium majus*, Coll. et Hemsl., natural size.

Fig. 1, calyx laid open, showing the shortly stipitate pistil; 2, standard; 3, one of the wings; 4, one of the keel-petals; 5, the stamens; 6, ovary in section, showing the solitary ovule. All enlarged.

A very distinct species, having flowers at least double the size of those of *P. bracteosum*, the only previously known species of the genus, in which, too, the flowers are borne in quite small clusters. *P. bracteosum*, Benn., inhabits the Malay Archipelago from Java to Little Kei and the Philippines; and the discovery of a new species in Burma is an interesting fact.

Lespedeza juncea, *Pers.*, var. **sericea**, *Maxim.*; *Fl. Brit. Ind.* ii. p. 142; *Forest Fl. Burma*, i. p. 380 (species propria).—Shan hills at 4000 feet.

North India, throughout China and Japan, and in Australia.

Lespedeza decora, *Kurz*, *Forest Fl. Burma*, i. p. 381; *Fl. Brit. Ind.* ii. p. 144.—Shan hills at 3000 feet.

Burma.

Lespedeza parviflora, *Kurz*, *Forest Fl. Burma*, i. p. 381; *Fl. Brit. Ind.* ii. p. 144.—Shan hills at 4000 feet.

Burma.

Lespedeza sericophylla, *Coll. et Hemsl.*, n. sp.

Frutex amplus, ramulis floriferis crassiusculis angulatis appresse sericeo-hirsutis. *Folia* pinnatim trifoliolata, undique argenteo-sericea, breviter petiolata, cum petiolo 2–3 poll. longa; foliola brevissime petiolulata, crassa, mollia, elliptica, 1–1¾ poll. longa (lateralia minora). *Flores* mediocres, circiter 6 lineas longi, dense racemosi, pedicellis quam flores brevioribus, bracteis parvis persistentibus; calyx dense longeque hirsutus, subbilabiatus, lobis angustis acutis 2 superioribus alte connatis; petala

glabra, fere æquilonga; vexillum latum, fere exunguiculatum, inappendiculatum; alæ oblongæ, longe unguiculatæ, ungue gracillimo; carina longe graciliterque unguiculata, supra ungues biauriculata, longe rostrata; stamina diadelphia; ovarium breviter stipitatum, secus suturam superiorem barbatum, cæteroquin glabrum. *Legumen* ignotum.

Shan hills at 5000 feet.

This resembles *L. Davidii*, Franchet, in the size and shape of the leaflets, differing in the close silvery tomentum and also in the floral characters and in the ovary being hairy along the upper suture only.

Lespedeza Prainii, *Coll. et Hemsl.*, n. sp.

Frutex ornatus, 10-pedalis, ramulis floriferis graciliusculis striatis puberulis glabrescentibus, internodiis quam folia multo brevioribus. *Folia* pinnatim trifoliolata, graciliter petiolata, cum petiolo usque ad 2 poll. longa, petiolo fere capillari; stipulæ persistentes, angustissimæ, acutissimæ, 3–4 lineas longæ; foliola breviter petiolulata, tenuia, fere membranacea, obovata, 4–12 lineas longa, apice rotundata, apiculata, supra glabra, atroviridia, reticulata, subtus pallidiora, minute strigillosa; stipellæ obsoletæ. *Flores* purpurei, 6–8 lineas longi, dense racemosi, racemis axillaribus folia superantibus, pedunculis pedicellisque fere capillaribus; calycis glabrescenti lobi ovati, acuti; petala glabra, subæquilonga. *Legumen* breviter stipitatum, glabrum, ovato-oblongum, 5–6 lineas longum, reticulatum.

Shan hills plateau at 4000 feet, common.

Near the Chinese *L. macrocarpa*, Bunge, which has larger pallid leaves, longer racemes of pale flowers, and a ciliate pod.

Named after Dr. D. Prain, Curator of the Calcutta herbarium, who, with Dr. King, compared nearly the whole of the collection and described the new *Pediculares*.

Lespedeza sp., an *L. decoræ* var.?—Shan hills plateau at 3000 feet.

This has smaller, more hairy leaves, and much more densely clustered flowers than a specimen noted by Dr. Prain as exactly agreeing with Kurz's type of *L. decora* in the Calcutta herbarium.

Vicia sativa, *Linn.*; *Fl. Brit. Ind.* ii. p. 178.—Shan hills plateau at 4000 feet; probably a waif of cultivation.

Dumasia villosa, *DC.*, var. **leiocarpa,** *Baker*; *Fl. Brit. Ind.* ii. p. 183.—Shan hills at 6000 feet.

This variety is recorded from Sikkim, Khasia, and Ceylon, and the typical variety is common in India, extending to China, Java, Madagascar, and South-eastern Africa.

Shuteria hirsuta, *Baker*; *Fl. Brit. Ind.* ii. p. 182.—Shan hills at 3000 feet.

Khasia and Sikkim.

Shuteria suffulta, *Benth.*; *Fl. Brit. Ind.* ii. p. 182.—Shan hills terai at 2000 feet.

Burma and Tenasserim.

Teramnus labialis, *Spreng.*; *Fl. Brit. Ind.* ii. p. 184.—Meiktila.

Almost throughout the tropics, and southward in Africa to Natal.

Erythrina lithosperma, *Blume*; *Fl. Brit. Ind.* ii. p. 190; *Forest Fl. Burma*, i. p. 367.—Shan hills terai at 3000 feet.

Burma to Java and the Philippine islands.

Mucuna, sp., an var. *M. macrocarpæ*?; foliis crasse coriaceis rotundatis non acuminatis subtus molliter ferrugineo-pubescentibus, calycis dente inferiore valde elongato.

Shan hills plateau at 3000 feet.

Probably distinct from *M. macrocarpa*, Wall., but as the pod is unknown, and the flowers are so very similar, except in the long lower tooth of the calyx, we refrain from giving it a name. The calyx is light green, covered with short, brown, fulvous hairs; standard light green, tinged with purple towards the edge only; wings dark reddish purple; keel light greenish purple.

Pueraria Candollei, *R. Grah.*; *Fl. Brit. Ind.* ii. p. 197.—Shan hills terai at 3000 feet.

Pegu and Moulmein.

Pueraria Wallichii, *DC.*; *Fl. Brit. Ind.* ii. p. 198.—Shan hills at 5000 feet.

Eastern India and Burma.

Pueraria, sp. n.?—Shan hills at 4000 feet.

We have not matched this, but the specimen consists of a portion of a branch bearing one leaf and one raceme of flowers.

Butea frondosa, *Roxb.*; *Fl. Brit. Ind.* ii. p. 194; *Forest Fl. Burma*, i. p. 364.—Shan hills, *Aplin.*

Central and Southern India, Ceylon, and Burma.

Canavalia ensiformis, *DC.*; *Fl. Brit. Ind.* ii. p. 195.—Meiktila.

Generally diffused in tropical regions and commonly cultivated.

There is an imperfect specimen of a second species of this genus.

Cajanus indicus, *Spreng.*; *Fl. Brit. Ind.* ii. p. 217; *Forest Fl. Burma*, i. p. 377.—Shan hills terai, wild.

Probably a native of the Old World, but now spread all over the tropics through cultivation.

Atylosia mollis, *Benth.*; *Fl. Brit. Ind.* ii. p. 213.—Shan hills terai at 2000 feet.

Widely diffused in India and Malaya, extending to the Philippine islands.

Atylosia nivea, *Benth.*; *Fl. Brit. Ind.* ii. p. 214.—Meiktila.

Burma.

Atylosia barbata, *Baker*; *Fl. Brit. Ind.* ii. p. 216.—Shan hills terai at 2000 feet.

Eastern India to Java.

Atylosia scarabæoides, *Benth.*; *Fl. Brit. Ind.* ii. p. 215.—Meiktila.

Throughout India, Malaya, Southern China, and in the Mascarene islands.

Atylosia burmanica, *Coll. et Hemsl.*, n. sp.

Species (vel varietas) inter *A. mollem* et *A. villosam*, a priori differt legumine longe villoso, a posteriori differt foliis subtus aureo-tomentosis petiolis brevioribus crassioribus, floribus amplis in racemos elongatos terminalibus dispositis. *Flores* flavi, 12–15 lineas longi, densiuscule racemosi, nutantes, quam pedicelli longiores; calyx subbilabiatus, breviter pubescens, circiter 6

lineas longus, labio superiore deltoideo brevissime bidentato, labio inferiore trilobato, lobo intermedio fere duplo longiore acuto; petala subæquilonga, longe graciliterque unguiculata; vexillum obovato-rotundatum, basi bicornutum; alæ rectæ, longiusculæ, cornutæ; carina leviter incurva, obtusissima, lamina basi in lobam rotundatam producta; ovarium sessile, villosissimum, 6-ovulatum, stylo per totum piloso. *Legumen* immaturum circiter 15 lineas longum, longe aureo-villosum.

Shan hills at 5000 feet.

A common climber over bushes and undergrowth on the higher ranges of the Southern Shan States, conspicuous from its racemes of yellow flowers.

The flowers of *A. villosa*, Benth., to which this is most closely allied, are unknown, but it has much slenderer petioles and thinner, 3-nerved leaflets, clothed beneath with a very short grey pubescence.

Cylista scariosa, *Ait.*; *Fl. Brit. Ind.* ii. p. 219; *Forest Fl. Burma*, i. p. 377.—Shan hills terai at 3000 feet.

Southern India, Pegu and Martaban.

Rhynchosia bracteata, *Benth.*; *Fl. Brit. Ind.* ii. p. 225.—Meiktila.

Upper Gangetic plain and Burma.

Eriosema chinense, *Vogel*; *Fl. Brit. Ind.* ii. p. 219.—Near Pynmam.

Western India to Ceylon, China, Philippine islands, and Australia.

Flemingia paniculata, *Wall.*; *Fl. Brit. Ind.* ii. p. 227; *Forest Fl. Burma*, i. p. 372.—Shan hills terai at 2000 feet.

Northern India, from Kumaon eastward and southward to Tenasserim.

Flemingia congesta, *Roxb.* (varietates); *Fl. Brit. Ind.* ii. p. 228; *Forest Fl. Burma*, i. p. 374.—Shan hills at 2500–5000 feet.

Widely spread in India, Malaya, and China.

There are two distinct varieties in the collection. One is the same as Kurz's 2527, from Prome, and probably the *F. ferru-*

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ginea, Grah., of Kurz's 'Forest Flora.' The other has smaller flowers and clustered instead of solitary racemes, and is perhaps specifically different.

Flemingia sericans, *Kurz*; *Forest Fl. Burma*, i. p. 373; *Fl. Brit. Ind.* ii. p. 229, *sub* F. Wallichii; syn. F. nana, *Wall. Cat.* 5748 B.—Shan hills at 3000 to 5000 feet.

Prome and Martaban.

The Burmese plant appears to be different from the peninsular *F. Wallichii*, Wight et Arnott, with which it is united by Baker in the 'Flora of British India.' Whether some of the specimens referred by Baker to *F. congesta*, var. *nana*, belong here, is a question which cannot be answered without dissecting the flowers of a large number of specimens. We here refer to *F. sericans*, Kurz, specimens agreeing with 5748 B, Wall. Cat. ("*F. nana*, Roxb.?"), and with 2528, Pegu, Kurz; and other specimens identical with 1672 of the Kew distribution of Griffith's Burmese plants, labelled *F. congesta*, var. *nana*. These are all of stunted appearance, due to repeated browsing or fire.

Dalbergia cultrata, *R. Grah.*; *Fl. Brit. Ind.* ii. p. 233; *Forest Fl. Burma*, i. p. 342.—Shan hills terai at 3000 feet.

Ava to Tenasserim.

The specimen is very young, and almost exactly like 1165, Kurz, from Thoungyeen.

Dalbergia volubilis, *Roxb.*?; *Fl. Brit. Ind.* ii. p. 235; *Forest Fl. Burma*, i. p. 346.—Shan hills at 2000 to 4000 feet.

One of the commoner Indian species, extending to Ceylon and Pegu.

Our specimens are in a very young state.

Dalbergia, sp., an *D. velutinæ*, var.?; foliolis minoribus, floribus dense cymoso-paniculatis, paniculis axillaribus terminalibusve.—Shan hills at 5000 feet.

There is also a specimen in young fruit which may belong to this species.

Derris scandens, *Benth.*; *Fl. Brit. Ind.* ii. p. 240; *Forest Fl. Burma*, i. p. 339.—Shan hills.

Tropical India, Malaya, South China, and North Australia.

Pongamia glabra, *Vent.*; *Fl. Brit. Ind.* ii. p. 240; *Forest Fl. Burma*, i. p. 335.—Shan hills terai at 2000 feet.

Widely spread in tropical Asia, and extending to Polynesia and North Australia.

LEGUMINOSEÆ: *Cæsalpinieæ.*

Cæsalpinia Bonducella, *Fleming*; *Fl. Brit. Ind.* ii. p. 254.—Meiktila.

Throughout the tropics, including remote coral islands.

Cæsalpinia Sappan, *Linn.*; *Fl. Brit. Ind.* ii. p. 255; *Forest Fl. Burma*, i. p. 405.—Shan hills at 3000 feet.

Widely diffused in India and Malaya.

Cæsalpinia digyna, *Rottler*; *Fl. Brit. Ind.* ii. p. 256; *Forest Fl. Burma*, i. p. 407.—Meiktila.

India and Malaya, common.

Cæsalpinia sepiaria, *Roxb.*; *Fl. Brit. Ind.* ii. p. 256; *Forest Fl. Burma*, i. p. 406.—Meiktila.

Widely spread in India and Malaya, and extending to China and Japan.

Cassia Fistula, *Linn.*; *Fl. Brit. Ind.* ii. p. 261; *Forest Fl. Burma*, i. p. 391.—Shan hills at 3000 feet.

Central and Eastern India, Malaya and Southern China; often planted.

Cassia renigera, *Wall.*; *Fl. Brit. Ind.* ii. p. 262; *Forest Fl. Burma*, i. p. 392.—Shan hills at 1000 to 3000 feet.

Burma.

Cassia auriculata, *Linn.*; *Fl. Brit. Ind.* ii. p. 263; *Forest Fl. Burma*, i. p. 393.—Shan hills at 3000 feet.

Central and Southern India and Burma.

Bauhinia acuminata, *Linn.*; *Fl. Brit. Ind.* ii. p. 276; *Forest Fl. Burma*, i. p. 396.—Pynmanah.

North-west provinces of India to Ceylon, China, and the Malay archipelago.

Bauhinia variegata, *Linn.*; *Fl. Brit. Ind.* ii. p. 284; *Forest Fl. Burma*, i. p. 397.—Shan hills, 3000 to 5000 feet, common.

Western India to Burma and Southern China.

Bauhinia racemosa, *Lam.*; *Fl. Brit. Ind.* ii. p. 276; *Forest Fl. Burma*, i. p. 397.—Shan hills.

North-western provinces of India to Ceylon, China, and the Malay archipelago, eastward to Timor.

Bauhinia (§ **Phanera**) **diptera,** *Coll. et Hemsl.*, n. sp.

Frutex scandens, undique glaberrimus, ramulis floriferis subangulatis gracillimis. *Folia* 2-foliolata, graciliter petiolata; foliola sessilia, fere membranacea, ovali-elliptica, 9–12 lineas longa, utrinque rotundata, 3–4-nervia, subtus pallidiora; petiolus fere filiformis, 9–15 lineas longus; stipulæ minutæ, citissimo deciduæ. *Flores* mediocres (circiter $1\frac{1}{2}$ poll. diametro), laxe corymboso-racemosi, longe graciliterque pedicellati, corymbis 5–11-floris; calycis lobi lati, circiter 4 lineas longi, apiculati, plus minus connati (sæpius 2 inter se et 3 inter se connati), subspathaceam expansi, persistentes; petala inæqualia, anguste spathulata, crispata; stamina 3 perfecta, petala longe superantia, circiter sesquipollicaria; ovarium longissime stipitatum, circiter 12-ovulatum, stylo stamina perfecta æquante. *Legumen* ignotum.

Shan hills at 4000 feet.

Not very closely allied to any species, and characterized by a very slender habit and by being glabrous in all parts.

Bauhinia (§ **Pileostigma**) **tortuosa,** *Coll. et Hemsl.*, n. sp. (Plate VIII.)

Arbor parva, nodosa, tortuosa, novellis tomentosis, dense racemosa, ramulis floriferis brevibus gracilibus dense foliatis. *Folia* breviter petiolata, subcoriacea, breviter bilobata, lobis rotundatis, cordato-rotundata, latiora quam longa, maxima $1\frac{1}{2}$ poll. diametro, 9-nervia, supra glabra, reticulata, subtus tomentosa, nervis petiolisque ferrugineo-tomentosis, petiolis 3–4 lineas longis. *Flores* (polygami?) pubescentes, 5–6 lineas diametro, breviter pedicellati, in racemos parvos densos (minoribus floribus 2–3 inferioribus tantum expansis vix pollicaribus) laterales vel subterminales dispositi; calycis lobi late ovati, obtusi, plus minusve connati et spathaceam expansi; petala subæqualia, obovato-spathulata, calycem triente excedentia; stamina omnia perfecta, alterna breviora; ovarium subsessile, dense villosum, 2-ovulatum (an semper?), stylo subnullo. *Legumen* non visum.

Koni at 5000 feet.

Near *B. malabarica*, Roxb., but altogether of smaller dimensions,

with short, relatively thick pedicels and two or few ovules. Nearer still to the recently published Chinese *B. Faberi*, Oliver (Hooker's 'Icones Plantarum,' t. 1790), which is much more slender and nearly glabrous, with fewer-flowered racemes. We have not succeeded in finding what we could be sure was a perfect pistil, and we suspect that the flowers are really polygamous.

DESCRIPTION OF PLATE VIII.

Branch of *Bauhinia tortuosa*, Coll. et Hemsl., natural size.

Fig. 1, a flower; 2, imperfect pistil; 3, section of ovary. Enlarged.

Leguminosæ: *Mimoseæ*.

Entada scandens, *Benth.*; *Fl. Brit. Ind.* ii. p. 287; *Forest Fl. Burma*, i. p. 416.—Shan hills at 4000 feet.

Throughout the tropics.

Adenanthera pavonina, *Linn.*; *Fl. Brit. Ind.* ii. p. 287; *Forest Fl. Burma*, i. p. 417.—Shan hills terai at 2000 feet.

Generally diffused in tropical Asia and extending into some subtropical regions; also in Australia.

Dichrostachys cinerea, *Wight et Arnott*; *Fl. Brit. Ind.* ii. p. 288.—Meiktila.

North-west provinces of India and South India to Ceylon.

Mr. Bentham (Trans. Linn. Soc. xxx. p. 383) regards the Malayan and N.-Australian specimens, formerly referred to this species, as belonging rather to the closely-allied tropical-African *D. nutans*, Benth.

Neptunia triquetra, *Benth.*; *Fl. Brit. Ind.* ii. p. 286.—Meiktila.

Central and South India.

Mimosa pudica, *Linn.*; *Fl. Brit. Ind.* ii. p. 291.—Shan States.

Now common in tropical India, though supposed to be a colonist from America.

Acacia Farnesiana, *Willd.*; *Fl. Brit. Ind.* ii. p. 292; *Forest Fl. Burma*, i. p. 420.—Shan hills at 4000 feet.

Commonly planted, and now diffused in a wild state throughout the warm regions of the earth.

Acacia Sundra, *Spreng.*; *Fl. Brit. Ind.* ii. p. 295; *Forest Fl. Burma*, i. p. 422.—Meiktila.

South India, Ceylon, and Burma.

Acacia pennata, *Willd.*; *Fl. Brit. Ind.* ii. p. 297; *Forest Fl. Burma*, i. p. 424.—Shan hills at 3000 feet.

Widely spread in tropical Asia and tropical Africa, southward to Natal.

Acacia concinna, *DC.*; *Fl. Brit. Ind.* ii. p. 296; *Forest Fl. Burma*, i. p. 423.—Shan hills plateau at 4000 feet.

Widely spread in India and Malaya, and extending to South China.

Albizzia lucida, *Benth.*; *Fl. Brit. Ind.* ii. p. 299; *Forest Fl. Burma*, i. p. 429.—Shan hills terai at 2000 feet.

Eastern India and Malay peninsula.

Albizzia odoratissima, *Benth.*; *Fl. Brit. Ind.* ii. p. 299; *Forest Fl. Burma*, i. p. 427.—Shan hills at 4000 feet.

Central and Southern India, Ceylon, and Malacca.

Albizzia stipulata, *Boivin*; *Fl. Brit. Ind.* ii. p. 300; *Forest Fl. Burma*, i. p. 426.—Shan hills at 5000 feet.

Widely spread in India, Ceylon, and Malaya.

Pithecolobium angulatum, *Benth.*; *Fl. Brit. Ind.* ii. p. 306; *Forest Fl. Burma*, i. p. 430.—Shan hills terai at 3000 feet.

Eastern India and Malaya.

ROSACEÆ.

Prunus Puddum, *Roxb.*; *Fl. Brit. Ind.* ii. p. 314; *Forest Fl. Burma*, i. p. 434.—Shan hills terai at 3000 feet.

Northern and Eastern India and Burma.

Rubus moluccanus, *Linn.*; *Fl. Brit. Ind.* ii. p. 330; *Forest Fl. Burma*, i. p. 437.—Shan hills at 3000 to 4000 feet.

Widely spread in tropical India and Malaya, and extending to Southern China and Australia.

Rubus ellipticus, *Smith*; *Fl. Brit. Ind.* ii. p. 336; syn. R. flavus, *Hamilt.*; *Forest Fl. Burma*, i. p. 438.—Shan hills at 3000 feet.

South India and Sikkim to Western China.

A variety having almost truncate leaflets, and the same variety was collected in Muneypore by Dr. Watt.

Rubus lasiocarpus, *Smith*; *Fl. Brit. Ind.* ii. p. 339; *Forest Fl. Burma*, i. p. 439.—Shan hills plateau at 4000 feet.

Temperate regions throughout India and Malaya.

Fragaria indica, *Linn.*; *Fl. Brit. Ind.* ii. p. 343.—Shan hills terai at 3000 feet.

Afghanistan to Ceylon, Java, and Japan.

Potentilla Kleiniana, *Wight et Arnott*; *Fl. Brit. Ind.* ii. p. 359. —Shan hills plateau, 5000 feet.

Kashmir to Ceylon, Khasia, Java, China, and Japan, in temperate regions.

Agrimonia Eupatorium, *Linn.*; *Fl. Brit. Ind.* ii. p. 361.—Shan hills at 4000 feet.

Western Europe to Japan, and also in North America.

Poterium longifolium, *Bertol.*; *Fl. Brit. Ind.* ii. p. 363.—Shan hills at 4000 feet.

Khasia hills at 5000 to 6000 feet.

Rosa gigantea, *Collett*; *Crépin in Comptes-Rendus Soc. Bot. Belg.* 1888, p. 150, et 1889, p. 11; *Gard. Chron.* 3rd series, vi. p. 13. (Plate IX.).—Shan hills plateau at 4000 to 5000 feet; abundant, though local.

Also in Muneypore, where Dr. Watt discovered it in 1882, at at an altitude of 6000 feet.

A lofty climber with very thick stems, very conspicuous in the forests by reason of its large white flowers. A walking-stick made from a stem of this Rose has been deposited in the Kew Museum.

It is doubtful whether this is more than a very luxuriant state of *R. indica*, Linn., for some of the older specimens have flowers no more than 2 to 2½ inches in diameter, and the flowers are sometimes corymbose.

DESCRIPTION OF PLATE IX.

Flowering-branches of *Rosa gigantea*, Coll., natural size.

Fig. 1, portion of an older branch showing the shape and direction of the thorns, natural size; 2, two young capsules, enlarged; 3, a fruit, natural size; 4, a ripe carpel, twice natural size.

The flowers drawn from Collett's specimens; the piece of old branch, fruit, and carpels from Watt's specimens.

Rosa Collettii, *Crépin in Comptes-Rendus Soc. Bot. Belg.* 1889, p. 49. (Plate X.).—Shan hills, 3000 to 4000 feet, common in certain localities on the banks of streams.

DESCRIPTION OF PLATE X.

A branch of *Rosa Collettii,* Crépin, natural size.

Fig. 1, vertical section of the receptacle showing the carpels; 2, a single carpel: enlarged; 3, young fruit, natural size when dry.

Pyrus Pathia, *Ham.*; *Fl. Brit. Ind.* ii. p. 374; *Forest Fl. Burma,* i. p. 441.—Shan hills plateau at 4000 feet.

Kashmir to Western China.

Docynia indica, *Decne.*; *Fl. Brit. Ind.* ii. p. 369.—Shan hills at 4000 feet.

Eastern India to Western China.

Eriobotrya dubia, *Decne.*?; *Fl. Brit. Ind.* ii. p. 371; *Forest Fl. Burma,* i. p. 443.—Shan hills at 6000 feet.

Eastern India and Burma.

The specimens are young, and we are not quite certain that it is this species.

Stranvæsia glaucescens, *Lindl.*; *Fl. Brit. Ind.* ii. p. 382.—Shan hills at 5000 feet.

North India from Kumaon to Khasia.

Osteomeles anthyllidifolia, *Lindl. in Trans. Linn. Soc.* xiii. p. 98, t. 8.—Shan hill plateau at 4000 to 5000 feet; very abundant in some parts of the Southern Shan States, especially about Koni, and conspicuous in the spring from the profusion of its small white flowers, recalling the blackthorn.

There are specimens of this interesting plant in the Kew Herbarium from Pitcairn island, Mangaia island, and the Sandwich and Bonin groups; and it is also recorded from the Luchu islands and Japan. All the other species of the genus are Andine.

SAXIFRAGACEÆ.

Dichroa febrifuga, *Lour.*; *Fl. Brit. Ind.* ii. p. 406.—Shan hills, near the summit where the snow had lately lain, *Manders.*

North India, Java and the Philippines.

Itea riparia, *Coll. et Hemsl.*, n. sp.

Frutex parvus, ramulis floriferis elongatis rectis graciliusculis striatis primum minute puberulis. *Folia* subcoriacea, lanceolata, in petiolum brevem attenuata, $2\frac{1}{2}$–$3\frac{1}{2}$ poll. longa, acuta, pauci-calloso-denticulata, utrinque glaberrima, subtus pallidiora. *Flores* 4–5 lineas diametro, in racemos terminales erectos usque ad 6 poll. longos dispositi; calycis minutissime puberuli dentes deltoidei, vix acuti; petala angusta, apice leviter inflexa; stamina 5, antherarum loculis demum basi divaricatis. *Carpella* 2, stigmatibus connatis.

Shan hills at 2000 to 4000 feet. Common on river-banks throughout the Southern Shan States.

Narrow leaves, straight branches, and erect racemes characterize this species.

DROSERACEÆ.

Drosera Burmanni, *Vahl*; *Fl. Brit. Ind.* ii. p. 424.—Shan hills at 3000 feet.

Tropical and subtropical Asia, eastward to Japan, and in Africa and Australia.

Drosera peltata, *Smith*; *Fl. Brit. Ind.* ii. p. 424.—Shan hills, 4400 to 6000 feet, *Manders* and *Collett*.

India and China to Australia.

RHIZOPHOREÆ.

Carallia integerrima, *DC.*; *Fl. Brit. Ind.* ii. p. 439; syn. C. lucida, *Kurz*, *Forest Fl. Burma*, i. p. 451.—Shan hills, *Aplin*.

India, Malaya, South China, and Australia.

COMBRETACEÆ.

Terminalia tomentosa, *Wight et Arnott*; *Fl. Brit. Ind.* ii. p. 447; syn. T. alata, *Roth*; *Forest Fl. Burma*, i. p. 458.—Shan hills at 3000 to 4000 feet.

North-west provinces of India to Ceylon and Burma.

Calycopteris floribunda, *Lam.*; *Fl. Brit. Ind.* ii. p. 449; *Forest Fl. Burma*, i. p. 468.—Shan hills terai at 2000 feet.

South India, Assam, and Singapore.

We have what appears to be a second species of this genus; but it is leafless and otherwise insufficient for description.

Anogeissus acuminata, *Wall.*; *Fl. Brit. Ind.* ii. p. 450; *Forest Fl. Burma*, i. p. 466.—Shan hills.

North-west provinces of India to the Deccan, Orissa, and Burma.

Anogeissus phillyreæfolia, *Huerck et Muell. Arg.*; *Fl. Brit. Ind.* ii. p. 451.—Yemethen.

Prome, Pegu, and Ava.

Combretum trifoliatum, *Vent.*; *Fl. Brit. Ind.* ii. p. 454; *Forest Fl. Burma*, i. p. 461.—Shan hills.

Burma to Singapore and Java.

Combretum apetalum, *Wall.*; *Fl. Brit. Ind.* ii. p. 453; *Forest Fl. Burma*, i. p. 460.—Meiktila.

Pegu and Burma.

Combretum nanum, *Ham.*; *Fl. Brit. Ind.* ii. p. 457.—Shan hills plateau at 4000 feet.

North India, from the Punjab to Sikkim.

Combretum deciduum, *Coll. et Hemsl.*; syn. C. ovale, *Kurz, Forest Fl. Burma*, i. p. 462, non *R. Br.*—Shan hills at 1000 feet.

Pegu and Martaban.

Quisqualis indica, *Linn.*; *Fl. Brit. Ind.* ii. p. 459; *Forest Fl. Burma*, i. p. 467.—Shan hills at 3000 feet, certainly wild.

Burma and Malay peninsula, and generally cultivated in the tropics.

MYRTACEÆ.

Tristania burmanica, *Griffith*; *Fl. Brit. Ind.* ii. p. 466; *Forest Fl. Burma*, i. p. 474.—Shan hills terai at 3000 feet.

Burma to Java and Borneo.

Eugenia macrocarpa, *Roxb.*; *Fl. Brit. Ind.* ii. p. 474, *Forest Fl. Burma*, i. p. 492.—Shan hills terai at 2000 to 3000 feet.

Eastern India, Malay peninsula and archipelago.

Eugenia Jambolana, *Lam.*; *Fl. Brit. Ind.* ii. p. 499.—Shan hills terai at 2000 feet.

Widely spread in India and Malaya and extending to North Australia.

There are specimens in the collection of one more species of *Eugenia* which we have not matched.

Barringtonia acutangula, *Gærtn.*; *Fl. Brit. Ind.* ii. p. 508; *Forest Fl. Burma*, i. p. 497.—Near Posobio.

Throughout India and Malaya, and extending to North Australia.

Careya herbacea, *Roxb.*; *Fl. Brit. Ind.* ii. p. 510; *Forest Fl. Burma*, i. p. 499.—Shan hills at 4000 feet.

Kumaon to Khasia and Chittagong.

Careya arborea, *Roxb.*?; *Fl. Brit. Ind.* ii. p. 511; *Forest Fl. Burma*, i. p. 499.—Shan hills terai at 2000 feet.

Throughout India and southward in the east to Tenasserim.

The Shan specimens may possibly belong to the obscure *C. sphærica*, Roxb.

MELASTOMACEÆ.

Sonerila stricta, *Hook.*, var. **burmanica**, *Clarke*; *Fl. Brit. Ind.* ii. p. 530.—Shan hills terai at 2000 feet.

Khasia to Tenasserim.

Osbeckia capitata, *Benth.*; *Fl. Brit. Ind.* ii. p. 516.—Shan hills at 4000 feet.

Common in Eastern India, from Bhotan to Khasia.

Melastoma normale, *D. Don*; *Fl. Brit. Ind.* ii. p. 524; *Forest Fl. Burma*, i. p. 504.—Shan hills, 4000 to 5000 feet.

Nepal to Bhotan, Khasia and Martaban.

LYTHRACEÆ.

Lagerstrœmia indica, *Linn.*; *Fl. Brit. Ind.* ii. p. 575; *Forest Fl. Burma*, i. p. 521.—Shan hills at 4000 feet.

Eastern India, China, Malaya, and North Australia, and commonly cultivated.

Lagerstrœmia macrocarpa, *Wall.*; *Forest Fl. Burma*, i. p. 524. —Shan hills at 4000 feet.

Ava to Moulmein.

Lagerstrœmia villosa, *Wall.*; *Fl. Brit. Ind.* ii. p. 578; *Forest Fl. Burma*, i. p. 524.—Shan hills at 3000 feet.

Pegu and Martaban.

Lagerstrœmia tomentosa, *Presl*; *Fl. Brit. Ind.* ii. p. 578; *Forest Fl. Burma*, i. p. 522.—Shan hills at 3000 feet.

Pegu and Martaban.

Lagerstrœmia (§ **Pterocalymma**) sp. aff. L. piriformi, *Koehne.* —Near Yindaw, in the plains of Upper Burma.

This is very closely allied to the Philippine-island species *L. piriformis*, Koehne, but the specimen is in very young bud only.

Woodfordia floribunda, *Salisb.*; *Fl. Brit. Ind.* ii. p. 572; *Forest Fl. Burma*, i. p. 518, sub nomine W. fruticosa, *Kurz.*—Shan hills at 4000 feet.

Baluchistan to China, and in tropical Africa and Madagascar.

Ammannia baccifera, *Linn.*; *Fl. Brit. Ind.* ii. p. 569.—Shan hills at 4000 feet.

Tropical Asia, Africa, and Australia, and extending into some subtropical and temperate regions, as Afghanistan, China, and Japan.

Ammannia peploides, *Spreng.*; *Fl. Brit. Ind.* ii. p. 566.—Shan hills at Meiktila.

Persia eastward to Japan and southward in the Malay peninsula and archipelago.

Ammannia rotundifolia, *Ham.*; *Fl. Brit. Ind.* ii. p. 566.—Shan hills at 5000 feet.

Very widely spread in tropical and subtropical Asia and extending to Japan.

Onagraceæ.

Epilobium pannosum, *Haussk.* (syn. E. khasianum, *Clarke*; *Fl. Brit. Ind.* ii. p. 585), var.? glabrescens.—Shan hills at 4000 feet.

Khasia mountains.

The Shan specimen is almost glabrous and the leaves thick and hard; but there is no other obvious difference.

Jussiæa repens, *Linn.*; *Fl. Brit. Ind.* ii. p. 587.—Meiktila.

Almost cosmopolitan in warm regions.

SAMYDACEÆ.

Casearia graveolens, *Dalzell*; *Fl. Brit. Ind.* ii. p. 592.—Shan hills at 5000 feet.

Gurhwal and Kumaon southward in the Deccan peninsula and eastward to Burma.

CUCURBITACEÆ.

Trichosanthes palmata, *Roxb.*?; *Fl. Brit. Ind.* ii. p. 606.—Shan hills at 4000 feet.

North India to Ceylon, Singapore, and the Malay archipelago.

Trichosanthes, sp.; foliis insigniter discoideo-tuberculatis alte palmato-lobatis, lobis obovato-oblongis fere truncatis paucidentatis.—Shan hills at 4000 feet.

Probably an undescribed species, but there are only quite young flower-buds.

Thladiantha calcarata, *Clarke*; syn. T. dubia, *auctor. nonnul. non Bunge*; *DC. Monogr. Phanerog.* iii. p. 423.—Shan hills terai at 3000 feet.

Eastern India to Pegu.

Zehneria umbellata, *Thwaites*; *Fl. Brit. Ind.* ii. p. 625.—Shan hills at 4000 to 5000 feet.

Throughout India and Malaya and reaching South China and North Australia.

FICOIDEÆ.

Mollugo hirta, *Thunb.*; *Fl. Brit. Ind.* ii. p. 662.—Meiktila.

Generally dispersed in warm countries.

UMBELLIFERÆ.

Hydrocotyle asiatica, *Linn.*; *Fl. Brit. Ind.* ii. p. 669.—Shan hills terai at 2000 feet.

Almost cosmopolitan in the tropics and extending to some temperate regions, including Japan, the Bermudas, and Tasmania.

Hydrocotyle javanica, *Thunb.*; *Fl. Brit. Ind.* ii. p. 667.—Shan hills, 2000 to 5000 feet.

Tropical Asia to Southern China and Southern Japan; also in Eastern Africa and Australia.

Hydrocotyle ecostata, *Coll. et Hemsl.*, n. sp.

Herba annua, undique glaberrima, ramosissima, habitu *H. rotundifoliæ* sed gracilior. *Folia* longe graciliterque petiolata, subcarnosa, ambitu reniformi-rotundata, maxima 8 lineas diametro, lobis sæpius rotundato-tridentatis interdum integris. *Flores* minuti, sessiles, pauci, fasciculati, pedunculo interdum simplice sed sæpius ramoso vel floribus verticillatis infra umbellam terminalem instructo; petala valvata. *Fructus* vix semilineam diametro, glaber, lævis, ecostatus, a latere compressus sed commissura lata margine tenui, stylis brevibus.

Shan hills at 4000 feet.

In general appearance this resembles the common *H. rotundifolia*, but the usually compound inflorescence and the very small ribless fruit with a very broad commissure at once distinguish it.

Bupleurum falcatum, *Linn.*, var. **marginatum**; *Fl. Brit. Ind.* ii. p. 676.—Shan hills at 5000 feet.

South of Europe and Asia Minor, through North India to China and Japan.

Pimpinella diversifolia, *DC.*; *Fl. Brit. Ind.* ii. p. 688.—Shan hills at 5000 feet.

Throughout the Himalaya mountains eastward to Central and Southern China.

Œnanthe stolonifera, *DC.*; *Fl. Brit. Ind.* ii. p. 696.—Shan hills at 4000 feet.

North India from the Punjab and Kashmir eastward to Japan and southward to Java.

Peucedanum Dhana, *Ham.*; *Fl. Brit. Ind.* ii. p. 709.—Shan hills at 4000 feet.

Kumaon to North Bengal.

Araliaceæ.

Heptapleurum venulosum, *Seem.*; *Fl. Brit. Ind.* ii. p. 729; *Forest Fl. Burma*, i. p. 538 —Shan hills, 2000 to 4000 feet.

Throughout India and Malaya, and reaching tropical Australia.

There may be more than one species among the specimens here referred to *H. venulosum*. To one form, indeed, Dr. Watt has given a manuscript name, but the material is insufficient to enable us to come to a decision respecting its claim to specific rank.

Heteropanax fragrans, *Seem.*; *Fl. Brit. Ind.* ii. p. 734; *Forest Fl. Ind.* i. p. 541.—Shan hills, *Aplin*.

North India, Malaya, and China.

Tupidanthus calyptratus, *Hook. f. et Thoms.*; *Fl. Brit. Ind.* ii. p. 740; *Forest Fl. Burma*, i. p. 512.—Shan hills terai at 3000 feet.

Eastern India and Burma.

Cornaceæ.

Marlea begoniæfolia, *Roxb.*; *Fl. Brit. Ind.* ii. p. 743; *Forest Fl. Burma*, i. p. 544.—Shan hills at 4000 feet.

North-west provinces of India to China, Japan, and Malaya.

Caprifoliaceæ.

Viburnum fœtidum, *Wall.*; *Fl. Brit. Ind.* iii. p. 4; *Forest Fl. Burma*, ii. p. 2.—Shan hills at 4000 feet.

Eastern India.

Lonicera macrantha, *DC.*; *Fl. Brit. Ind.* iii. p. 10.—Shan hills, 4000 to 5000 feet.

Nepal to Bhotan and Khasia.

Var. **biflora**, *Coll. et Hemsl.*; pilis longis patentibus vestita, foliis subtus pallidis, pedunculis axillaribus elongatis bifloris, corollis angustissimis 1½–2 poll. longis.

Shan hills at 5000 feet.

There are similar specimens in the Kew Herbarium from Sikkim, and, although very different from typical *H. macrantha*, they are connected by intermediate states.

Lonicera obscura, *Coll. et Hemsl.*, n. sp.

Frutex scandens, glabrescens, foliis iis *L. glabratæ* simillimis. *Flores* glabri, geminati, pedunculis brevibus; calycis lobi brevissimi, ovati, obtusi; corolla angustissima, circiter bipollicaris, labiis brevibus nec reflexis.

Shan hills at 3500 to 4000 feet.

In foliage this is so exactly like *L. glabrata*, Wall., that one might suspect it to be a hybrid between that and some other species. The long narrow flowers at once distinguish it. *L. leiantha*, Kurz, has similar foliage.

Lonicera (§ **Xylosteum**) **Hildebrandiana,** *Coll. et Hemsl.*, n. sp. (Plate XI.)

Frutex erectus ? undique glaberrimus, ramulis floriferis rectis teretibus rubentibus. *Folia* longiuscule petiolata, papyracea, late ovata, cum petiolo 4–5 poll. longa, abrupte acuminata, simul obtusa, basi rotundata, venis primariis lateralibus utrinque 4–5, lamina secus petiolum anguste decurrenti. *Flores* geminati, usque ad 7 poll. longi, pedunculis axillaribus solitariis vix 3 lineas longis, bracteolis squamæformibus; calycis limbus cupularis, obtuse dentatus; corolla leviter curvata, alte bilabiata, labium superius alte 4-lobatum, suberectum, lobis rotundatis leviter undulatis; stamina inclusa, filamentis puberulis; stylus brevior, stigmate capitato. *Fructus* pomaceus, ovoideus, pollicaris.

Shan hills at 5000 feet; only one plant was seen.

This is beyond comparison much the largest-flowered species hitherto described *.

We have named this *Lonicera* after Mr. Hildebrand, who was Superintendent of the Southern Shan States, and kindly gave much assistance in collecting.

DESCRIPTION OF PLATE XI.

Lonicera Hildebrandiana, Coll. et. Hemsl.—Flowering and fruiting branchlets; natural size.

Fig. 1, upper portion of stamen; 2, stigma. Enlarged.

RUBIACEÆ.

Stephegyne parvifolia, *Korth.*; *Fl. Brit. Ind.* iii. p. 25; *Forest Fl. Burma*, ii. p. 66, *sub* Nauclea.—Meiktila.

From the Punjab to Ceylon and Burma.

Stephegyne diversifolia, *Hook. f.*; *Fl. Brit. Ind.* iii. p. 26; *Forest Fl. Burma*, ii. p. 67.—Shan hills, *Aplin.*

Eastern India and Malaya to the Philippine islands.

* In the Kew Herbarium are specimens of a *Lonicera* closely allied to the above, which may be named *L. Braceana*, Hemsl., after Mr. L. J. K. Brace, formerly Curator of the Calcutta herbarium, who first pointed out that it was undescribed.—Species ab *L. Hildebrandiana* differt foliis magis carnosis oblongo-lanceolatis, petiolo longiore, floribus minoribus (maximis 4-pollicaribus), calycis dentibus magis evolutis acutis, corollæ labio superiore breviter 4-lobato.—Khasia mountains, *L. J. K. Brace* and *C. B. Clarke.* Specimens also received from Mr. F. Sander, of St. Albans, labelled "Assam."

Luculia gratissima, *Sweet*; *Fl. Brit. Ind.* iii. p. 36; *Forest Fl. Burma*, ii. p. 71.—Shan hills at 4000 feet.

Nepal eastward and southward to Ava.

Wendlandia glabrata, *DC.*; *Fl. Brit. Ind.* iii. p. 39; *Forest Fl. Burma*, ii. p. 74.—Shan hills terai at 2000 feet.

Mysore, Tenasserim, Western China, and Formosa.

Dentella repens, *Forst.*; *Fl. Brit. Ind.* iii. p. 42.—Meiktila.

Tropical Asia, Australia, and Polynesia.

Hedyotis capitellata, *Wall.*; *Fl. Brit. Ind.* iii. p. 56.—Shan hills terai at 3000 feet.

Malay peninsula and archipelago, and Western China.

Hedyotis fulva, *Hook. f.*; *Fl. Brit. Ind.* iii. p. 58.—Shan hills at 4000 feet.

Khasia mountains.

Hedyotis athroantha, *Coll. et Hemsl.*, n. sp.

Herba perennis? undique flavo-virente pubescens, caulibus erectis robustis simplicibus sesquipedalibus tetragonis, internodiis folia æquantibus vel brevioribus. *Folia* opposita vel ternatim verticillata, brevissime petiolata, crassiuscula, rigida, ovato-lanceolata, 3–5 poll. longa, subacuta, basi cuneata, venis primariis lateralibus circiter 5 crassis ex angulo acuto apicem versus excurrentibus. *Flores* densissime capitati, capitulis sessilibus vel pedunculatis 6–12 lineas diametro; calycis lati hispidi tubus ultra ovarium breviter productus, lobis sæpius 4 crassis lanceolato-oblongis vix acutis circiter 3 lineas longis recurvis; corolla crassa, quam calyx brevior, infundibularis, lobis valvatis oblongis apice inflexis extus pilosis; antheræ fauci corollæ subsessiles; ovarium 2-loculare, multiovulatum; stylus puberulus, exsertus, stigmate amplo capitato. *Capsula* non visa.

Shan hills at 4000 feet.

The very large hispid calyx and capitate flowers, associated with a greenish-yellow tomentum, and prominently nerved leaves characterize this species.

Oldenlandia corymbosa, *Linn.*; *Fl. Brit. Ind.* iii. p. 64.—Meiktila.

Tropical Asia, Africa, and America.

Oldenlandia gracilis, *DC.*; *Fl. Brit. Ind.* iii. p. 68.—Shan hills at 3000 feet.

Widely spread in tropical India and Burma.

Mussænda frondosa, *Linn.*; *Fl. Brit. Ind.* iii. p. 89.—Shan hills, 4000 feet.

Widely spread in India and Malaya, and extending to South-eastern China.

Mussænda incana, *Wall.*; *Fl. Brit. Ind.* iii. p. 87.—Shan hills at 4000 feet.

Nepal to Assam and Khasia.

Randia tomentosa, *Hook. f.*; *Fl. Brit. Ind.* iii. p. 110; syn. Gardenia dasycarpa, *Kurz*, *Forest Fl. Burma*, ii. p. 42.—Shan hills at 3000 feet.

Burma and Tenasserim.

Randia dumetorum, *Lam.*; *Fl. Brit. Ind.* iii. p. 110.—Shan hills at 4000 to 5000 feet.

Throughout tropical India and Malaya eastward to South China, and in tropical Africa.

Gardenia erythroclada, *Kurz*, *Forest Fl. Burma*, ii. p. 40; *Fl. Brit. Ind.* iii. p. 119.—Shan hills at 3000 feet.

All over Burma and Tenasserim.

Gardenia turgida, *Roxb.*; *Fl. Brit. Ind.* iii. p. 118; *Forest Fl. Burma*, ii. p. 41.—Shan hills at 4000 feet.

Kumaon to Madras and Ava.

There is an imperfect specimen of a third species of *Gardenia* near *G. lucida* and *G. gummifera.*

Knoxia corymbosa, *Willd.*; *Fl. Brit. Ind.* iii. p. 128.—Shan hills at 4000 to 5000 feet.

India and Malaya to South-eastern China and North Australia.

Vangueria spinosa, *Roxb.*; *Fl. Brit. Ind.* iii. p. 136, quoad var. c; *Forest Fl. Burma*, ii. p. 34.—Shan hills at 4000 feet.

India and Malaya.

Vangueria pubescens, *Kurz*, *Forest Fl. Burma*, ii. p. 34.—Shan hills at 3000 to 5000 feet.

India and Malaya.

Ixora sp. an *I. grandifoliæ* var.?—Shan hills at 4500 feet.
Specimen insufficient for satisfactory determination.

Pavetta indica, *Linn.*; *Fl. Brit. Ind.* iii. p. 150; syn. Ixora Pavetta, *Roxb.*; *Forest Fl. Burma*, ii. p. 11.—Shan hills at 4000 feet.

India and Malaya to South-eastern China and North Australia.

A variety with very broad pubescent leaves, cordate at the base.

Morinda tinctoria, *Roxb.*; *Fl. Brit. Ind.* iii. p. 156; syn. M. exserta, *Roxb.*; *Forest Fl. Burma*, ii. p. 59.—Shan hills terai at 2000 feet.

Throughout India and Malaya.

Pæderia tomentosa, *Blume*; *Fl. Brit. Ind.* iii. p. 197.—Shan hills terai at 2000 feet.

Eastern India and Malay peninsula eastward to Japan.

Pæderia lanuginosa, *Wall.*; *Fl. Brit. Ind.* iii. p. 196; *Forest Fl. Burma*, ii. p. 76.—Shan hills at 2000 to 3000 feet.

Malay peninsula.

Leptodermis crassifolia, *Coll. et Hemsl.*, n. sp.

Frutex dense ramosus, novellis plus minusve rigide pilosis, ramulis floriferis lateralibus brevibus densissime foliatis. *Folia* breviter petiolata, coriacea, confertissima, oblonga, ovata vel orbicularia, maxima semipollicaria, glabrescentia vel subtus parce pilosa, venis lateralibus primariis utrinque 2–3. *Flores* sessiles, fasciculati, albi, semipollicares, puberuli; bracteolæ membranaceæ, hyalinæ, puberulæ, alte connatæ, tridentatæ, dente intermedio longiore cuspidato, calycis dimidium æquantes; calyx præter lobos ciliolatos glaber, lobis crassis ovatis subobtusis persistentibus tubum æquantibus; corolla infundibularis, lobis latis intus insigniter papillosis subtrilobulatis, lobulis lateralibus tenuioribus induplicatis, tubo intus supra medium piloso; ovarium 5-loculare, stylo leviter exserto quinquefido lobis recurvis puberulis.

Shan hills at 4000 to 5000 feet; common on the grassy plateaux.

Characterized by the small, thick, crowded, rounded leaves.

A specimen with more slender branchlets, narrower leaves, and glabrous, or nearly so, in all its parts may be a variety of the foregoing or a distinct species.

Spermacoce stricta, *Linn. f.*; *Fl. Brit. Ind.* iii. p. 200.—Meiktila.

Tropical Asia and Africa.

Spermacoce hispida, *Linn.*; *Fl. Brit. Ind.* iii. p. 200.—Meiktila.

Widely spread in India and Malaya and eastward to South China.

Rubia crassipes, *Coll. et Hemsl.*, n. sp.

Herba robusta, scaberrima, caulibus tetragonis tuberculato-hispidis. *Folia* quaternatim verticillata, distincte petiolata (foliis 2 petiolis brevioribus, an semper ?), crassissima, rigida, ovato-oblonga vel elliptica, 1–1½ poll. longa, obtusa, basi rotundata, tuberculato-hispida, prominenter 3–5-nervia, nervis subtus elevatis, extimis brevibus. *Flores* . . . . in cymas trichotomas axillares et terminales dispositi, pedunculis pedicellisque crassis sulcatis hispidis. *Fructus* didymus (immaturus tantum visus) inermis.

Shan hills at 6000 feet.

In foliage this is nearest *R. cordifolia*, Linn., but yet so different that we have not hesitated to describe it as a distinct species.

Rubia Mandersii, *Coll. et Hemsl.*, n. sp.

Herba perennis? siccitate nigrescens, caulibus robustiusculis ramosis pedalibus quadrangularibus vel anguste quadrialatis ad angulos scabridis. *Folia* quaternatim verticillata, subsessilia, crassa, rigida, obovato-rotundata, fere orbicularia vel superiora minora ovato-lanceolata vel oblonga, margine scabrida, cæterum glabra, nuda, 3–5-nervia, nervis subtus elevatis. *Flores* pro genere mediocres, laxiuscule trichotomo-paniculati, graciliter pedicellati; corolla glabra, rotato-campanulata, lobis oblongis 3-striatis apice leviter incurvis; ovarium nudum, glabrum. *Fructus* ignotus.

Shan hills at 4000 feet, *Manders*.

Not closely resembling any species.

Named after Surgeon N. Manders, of the medical staff.

Galium boreale, *Linn.*?; *Fl. Brit. Ind.* iii. p. 205.—Shan hills at 4000 feet.

Specimen in very young flower.

G. boreale is widely spread in north temperate regions.

COMPOSITÆ.

Vernonia divergens, *Edgew. in Journ. As. Soc. Beng.* xxi. 1853, p. 172, reprint p. 48, et "errata" ad calcem; *Fl. Brit. Ind.* iii. p. 234.—Shan hills at 3000 feet.

Central and Eastern India, Burma, and Tenasserim.

Vernonia Clivorum, *Hance*; *Fl. Brit. Ind.* iii. p. 232.—Shan hills terai at 2000 feet.

Pegu, Martaban, Burma, and South-eastern China.

Vernonia (§ **Strobocalyx**) **Aplinii**, *Coll. et Hemsl.*, n. sp.

Arbor mediocris, ramulis floriferis robustis teretibus molliter albo-tomentosis. *Folia* ampla, distincte petiolata, coriacea, obovata vel lanceolato-oblonga, 8–12 poll. longa, apice rotundata, obtusa vel subacuta, basi cuneata, supra glabra, subtus cinereo- vel albido-tomentosa, venis primariis lateralibus utrinque circiter 12–15 conspicuis. *Capitula* sæpissime 8-flora, 5–6 lineas longa, brevissime pedunculata vel subsessilia, dense cymoso-paniculata; panicula terminalis, usque ad 12 poll. lata et 18 poll. longa, ramulis crassis dense albo-tomentosis; involucri bracteæ 5–6-seriatæ, crassæ, latæ, dense sericeo-appresse hirsutæ, exteriores gradatim breviores, obtusæ vel intimæ subacutæ; receptaculum leviter foveolatum; corolla pappum vix æquans. *Achænia*, immatura tantum visa, cuneiformia, compressa, appresse hirsuta; pappus albus, scabridus cum seriei extima brevissima.

Shan hills at 1700 to 5000 feet; originally collected by Mr. T. H. Aplin, of the Forest Department of Burma, after whom it is named.

Nearest to *V. talaumæfolia*, Hook. f. & Thoms., and very similar to it in the leaves, which, however, are softly tomentose beneath. The inflorescence is much denser in the present species; the pappus is white instead of red and the achenes densely hairy.

A common tree, attaining a height of thirty feet, inhabiting the higher parts of the terai forest forming the western boundary of the Shan States.

Vernonia gymnoclada, *Coll. et Hemsl.*, n. sp.

Frutex glaber, aphyllus (an semper?), ramulis crassiusculis multisulcatis. *Capitula* solitaria, secus ramulos laterales subsessilia, turbinata, 6–12 lineas diametro, multiflora; involucri bracteæ coriaceæ, rigidæ, anguste lanceolatæ, aculeato-cuspidatæ, interiores quam pappus breviores, extrinsecus gradatim breviores, extimæ squamiformes; receptaculum conicum, nudum. *Flores* purpurei; corollæ puberulæ vel pulverulentæ, tubo basi angustissimo sursum gradatim expanso, lobis angustis apice breviter inflexis obtusis. *Achænia* brevia, angulata, appresse albo-hirsuta; pappi setæ tenues, similes, uniseriatæ, pilosulæ subflavæ.

A common bush on the dry stony plains above Meiktila.

The leafless, deeply-furrowed branchlets, bearing distant solitary subsessile flower-heads, characterize this species.

Eupatorium Lindleyanum, *DC.*; *Forbes et Hemsley in Journ. Linn. Soc.* xxiii. p. 404.—Shan hills at 4000 feet.

Throughout China, and extending to Mandshuria and Japan.

The limits of this species and *E. japonicum*, Thunb., are not well defined, but the Shan specimens are almost exactly like some from Hongkong, having very narrow almost entire leaves.

Dichrocephala latifolia, *DC.*; *Fl. Brit. Ind.* iii. p. 245.—Shan hills at 5000 feet.

Tropical and subtropical Asia and Africa.

Grangea maderaspatana, *Poir.*; *Fl. Brit. Ind.* iii. p. 247.—Meiktila.

Tropical and subtropical Asia and Africa.

Microglossa volubilis, *DC.*; *Fl. Brit. Ind.* iii. p. 257; *Forest Fl. Burma*, ii. p. 82.—Shan hills at 3000 feet.

Eastern India, Malaya, China, Madagascar, and tropical Africa.

Conyza semipinnata, *Wall.*; *Fl. Brit. Ind.* iii. p. 257.—Meiktila.

Eastern India and Malaya.

Blumea glomerata, *DC.*; *Fl. Brit. Ind.* iii. p. 262.—Shan hills at 3000 feet, and plains of Upper Burma.

Widely spread in India, and extending to Java and South China.

Blumea hieracifolia, *DC.*; *Fl. Brit. Ind.* iii. p. 263 (varietates *typica* et *macrostachya*).—Shan hills terai at 2000 feet (var. *macrostachya*); and plateau at 4000 feet (var. *typica*).

Widely spread in India, and extending to Java and China.

Blumea balsamifera, *DC.*; *Fl. Brit. Ind.* iii. p. 270.—Yemethen.

Tropical India and Malaya, and the islands of Hainan and Formosa.

Blumea membranacea, *DC.*, var.; *Fl. Brit. Ind.* iii. p. 265.—Pyawbwe, plains of Upper Burma.

Throughout India and Malaya.

Blumea, sp. aff. *B. hieracifoliæ*, involucri bracteis latioribus.—Shan hills at 5000 feet.

We have not matched this, but the specimens are hardly sufficient to establish a new species in so difficult a genus.

Laggera flava, *Benth. et Hook. f. Gen. Pl.* ii. p. 290; *Fl. Brit. Ind.* iii. p. 270.—Shan hills.

Nearly all over India and the Malay peninsula.

Laggera alata, *Schultz-Bip.*; *Fl. Brit. Ind.* iii. p. 271.—Shan hills, Fort Stedman valley, *Aplin.*

India, Ceylon, Malaya, China, Philippine islands, and tropical Africa.

Laggera pterodonta, *Benth. et Hook. f. Gen. Pl.* ii. p. 290; *Fl. Brit. Ind.* iii. p. 271.—Shan hills terai at 2000 feet.

Tropical Asia and Africa.

Pluchea indica, *Less.*; *Fl. Brit. Ind.* iii. p. 272; *Forest Fl. Burma*, ii. p. 83.—Meiktila, in freshwater marsh.

India, Malaya, and South China.

Sphæranthus indicus, *Linn.*; *Fl. Brit. Ind.* iii. p. 275.—Yemethen.

Tropical India, Malaya, Africa, and Australia.

Pterocaulon cylindrostachyum, *Clarke*; *Fl. Brit. Ind.* iii. p. 275.—Meiktila.

Burma and Malaya to the Philippine islands, North Australia, and New Caledonia.

Anaphalis adnata, *DC.*; *Fl. Brit. Ind.* iii. p. 282.—Shan hills, *Aplin.*

North India from Simla to Khasia and in Martaban.

Anaphalis araneosa, *DC.*; *Fl. Brit. Ind.* iii. p. 283.—Popah hill at 5000 feet.

Western Himalaya to Khasia and Burma.

Gnaphalium multiceps, *Wall.*; *Fl. Brit. Ind.* iii. p. 288, sub *G. luteo-albo.*—Shan hills at 5000 feet.

North India, China, and Japan.

Gnaphalium indicum, *Linn.*; *Fl. Brit. Ind.* iii. p. 289.—Shan hills terai at 2000 feet.

Throughout tropical India and Malaya, eastward to China and southward to North Australia; also in tropical Africa.

Gnaphalium pulvinatum, *Delile*; *Fl. Brit. Ind.* iii. p. 289.—Shan hills.

Egypt, eastward through Afghanistan and Northern India to Burma.

Inula Cappa, *DC.*; *Fl. Brit. Ind.* iii. p. 295.—Shan hills; common on the grassy plateau, *Aplin.*

Northern and Eastern India, Malaya and China.

Inula polygonata, *DC.*; *Fl. Brit. Ind.* iii. p. 293.—Shan hills.

Pegu and Burma.

A tall handsome plant, common in dry forest.

Inula crassifolia, *Coll. et Hemsl.*, n. sp. (Plate XII.)

Herba erecta, striata, robusta, rigida, villosissima, caulibus striatis infra inflorescentiam simplicibus, internodiis brevibus. *Folia* (radicalia non visa) sessilia, semiamplexicaulia, crassissima, oblonga, maxima 2½ poll. longa, sursum sensim minora, adscen-

dentia vel caule appressa, obtusissima, pauce calloso-denticulata, supra scabra, subtus apresse villosa. *Capitula* solitaria vel interdum 3 aggregata, breviter pedunculata, radiata, $1\frac{1}{4}$–$1\frac{1}{2}$ poll. diametro; involucri bracteæ multiseriatæ, rigidæ, rubentes, plus minusve villosæ, interiores anguste lanceolatæ, acutæ, flores disci æquantes, exteriores breviores, latiores, obtusæ; receptaculum leviter concavum, areolatum. *Flores* radii numerosi, biseriati, ut videtur albi; corollæ angustæ. *Flores* disci numerosissimi, flavi; corollæ cylindricæ, tenuissimæ; antheræ longe caudatæ. *Achænia* (matura non visa) tenuia, teretia, appresse parceque hirsuta, basi distincte annuloso-callosa; pappi setæ circiter 15, corollam subæquantes, apice barbellatæ, cum seriei exteriore brevissima.—Shan hills at 5000 feet.

Not closely allied to any species.

Var. **glabrescens**, *Coll. et Hemsl.*, differt fere omnino glabra vel cito glabrescens.—Shan hills plateau at 5000 feet; common on the grassy uplands.

DESCRIPTION OF PLATE XII.

A. *Inula crassifolia*, Coll. et Hemsl., var. *villosa*.
B. *Inula crassifolia*, Coll. et Hemsl., var. *glabrescens*. Both natural size.

Fig. 1, a disk-flower; 2, anthers; 3, apex of style and stigma; 4, an immature achene; 5, a bristle of the pappus. All enlarged.

Vicoa auriculata, *Cass.*; *Fl. Brit. Ind.* iii. p. 297.—Meiktila.
The Punjab to Ceylon and Burma.

Anisopappus chinensis, *Hook. et Arn.*; *Forbes & Hemsley in Journ. Linn. Soc.* xxiii. p. 431.—Shan hills at 4000 to 5000 feet, *Aplin* and *Collett.*

Eastern and Western tropical Africa and South-eastern China.

Enhydra fluctuans, *Lour.*; *Fl. Brit. Ind.* iii. p. 304.—Yemethen, in the lake.

India, Malaya, tropical Africa, and Eastern Australia.

It is also recorded from China in the 'Flora of British India,' but we have seen no specimen.

Blainvillea latifolia, *DC.*; *Fl. Brit. Ind.* iii. p. 305.—Shan hills.

Dispersed throughout the tropics.

Wedelia calendulacea, *Less.*; *Fl. Brit. Ind.* iii. p. 306.—Shan hills at 3000 feet.

India, Malaya, China, and Japan.

Spilanthes Acmella, *Linn.*: *Fl. Brit. Ind.* iii. p. 307; *Kurz in Journ. As. Soc. Beng.* xlvi. (1877), 2, p. 176.—Upper Burma.

A variable plant, widely spread in warm countries.

Bidens pilosa, *Linn.*, var.; *Fl. Brit. Ind.* iii. p. 309.—Shan hills, 4000 feet.

Warm regions throughout the world.

Myriogyne minuta, *Less.*; syn. Centipeda orbicularis, *Lour.*; *Fl. Brit. Ind.* iii. p. 317.—Shan hills terai at 2000 feet.

Afghanistan to Ceylon, China, Australia, and Polynesia.

Gynura Pseudo-China, *DC.*; *Fl. Brit. Ind.* iii. p. 334.—Shan hills at 4000 feet.

India and Malaya.

Emilia sonchifolia, *DC.*; *Fl. Brit. Ind.* iii. p. 336.—Shan hills at 4000 feet.

Tropical and subtropical Asia and Africa, and colonized in America.

Notonia crassissima, *DC.*; *Fl. Brit. Ind.* iii. p. 338; *Kurz in Journ. As. Soc. Beng.* xlvi. 2, p. 194.—Meiktila.

Segain hills, Ava.

This has larger flower-heads than *N. grandiflora*, DC., more numerous involucral bracts with comose tips, and larger, pale, more strongly ribbed achenes. Griffith's figure (Ic. Pl. Asiat. t. 470) may, or may not, represent this plant.

A shrub with remarkably thick fleshy stems and branches. When not in flower it has the appearance and habit of one of the arboreous *Euphorbiæ*, such as *E. neriifolia*, Linn., which is common in the same localities.

Var. ? **prostrata**, *Coll. et Hemsl.*, n. var.

Frutex prostratus, supra rupes vagans ; folia bene evoluta non visa; capitula fere dimidio minora; achænia valde immatura tantum visa.

Shan hills at 4600 feet.

This may prove to be a distinct species, but the material is insufficient.

Notonia vestita, *Coll. et Hemsl.*, n. sp.

Frutex carnosus, novellis pilis albidis crassis flaccidis plus minusve instructis, foliis dense vestitis, ramis floriferis elongatis siccitate 3–4 lineas diametro. *Folia* bene evoluta non visa, sed ut videtur parva, crassa, obovato-oblonga, dentata vel forsan pinnatifida. *Capitula* circiter 9 lineas diametro, corymbosa, pro genere graciliter pedunculata; involucri bracteæ circiter 12, uniseriatæ, basi bracteolis paucis parvis instructæ, oblongæ, apice triangulatæ, subacutæ, dorso hispidulæ, margine late scariosæ, quam flores tertio parte breviores; receptaculum convexum, mammillatum. *Flores* numerosi . . . . *Achænia* brunnea vel rubentia, cylindrica, valde costata, glabra ; pappi setæ numerosæ, tenuissimæ, candidæ.

Shan hills terai, in the forest at 3000 feet.

This is evidently very distinct from all the other described species both in the indumentum and the foliage.

Senecio chrysanthemoidea, *DC.*, var. ; *Fl. Brit. Ind.* iii. p. 339. —Shan hills at 4000 feet.

North India, from Kashmir to Khasia.

Senecio scandens, *Ham.*; *Fl. Brit. Ind.* iii. p. 352.—Shan hills at 5000 feet.

North-western India to Ceylon and Eastern China.

Senecio Nagensium, *Clarke in Journ. Linn. Soc.* xxv. p. 39 ; syn. S. densiflorus, *Wall.*, var. ? Lobbii, *Hook. f. Fl. Brit. Ind.* iii. p. 355.—Shan hills at 3000 feet.

Muneypore and Tenasserim.

Mr. Clarke excludes the variety (?) *Lobbii* of *S. densiflorus*, on the ground that his *S. Nagensium* is rayless; but this character is now known to be inconstant, and in other respects they are exactly alike. *S. densiflorus*, var. ? *mishmiensis*, Hook. f., should also be referred here.

Echinops echinatus, *Roxb.*, var.? vel species nova, caulibus albo-araneosis, foliorum spinis multo brevioribus, capitulis inermis, achæniis fere glabris.

Shan hills at 4000 feet.

Most likely specifically distinct from *E. echinatus*, Roxb., but as there is only one imperfect inflorescence we prefer not giving it a name.

Saussurea affinis, *Spreng.*; *Fl. Brit. Ind.* iii. p. 373.—Shan hills at 5000 feet.

Eastern India to China and Japan, and in Eastern Australia.

Saussurea phyllocephala, *Coll. et Hemsl.*, n. sp.

Herba erecta, robusta, 8–9 ped. alta, omnino ferrugineo- vel albido-pubescens, hispidula. *Folia* (superiora capitulos subtendentia tantum adsunt) crassiuscula, sessilia, semiamplexicaulia (auriculis liberis), pinnatifida, 1½–3 poll. longa. *Capitula* anguste subracemoso-paniculata, lateralia breviter pedunculata, quasiterminalia, pedunculis longioribus, 9–18 lineas diametro (bene evoluta non visa); involucri bracteæ pluriseriatæ, subæquilongæ, flores superantes (?), extimæ (vel folia suprema) foliaceæ, oblongæ, breviter aculeato-denticulatæ, cæteræ lineares, rigidæ, minute puberulæ, sursum attenuatæ, plumosæ: receptaculum leviter convexum, paleis angustis dense instructum. *Flores* numerosissimi, glabri; staminum filamenta libera, glabra; antherarum caudæ longissimæ, fere integræ. *Achænia* juvenilia compressa; pappi setæ usque ad basin longe plumosæ.

Shan hills at 5000 feet.

The foliaceous outer involucral bracts, something in the way of *Carthamus*, sufficiently characterize this species. It is possible, however, that this character is not a constant one, and that we have here an abnormal condition of our *S. dealbata.*

Saussurea dealbata, *Coll. et Hemsl.*, n. sp.

Herba erecta, robusta, 6–7 ped. alta, caulibus puberulis striatis vel fere sulcatis cavis infra inflorescentiam simplicibus? *Folia* caulina papyracea, sessilia, semiamplexicaulia, basi auriculata (auriculis liberis), oblonga, pinnatifida vel subpinnatifida (lobis

obtusis), ad 6 poll. longa, supra hispidula, viridia, subtus præter costam nervosque canescentia. *Capitula* anguste racemoso-paniculata, distincte pedunculata, vix 1 poll. diametro; involucri bracteæ multiseriatæ, coriaceæ, lineares, acutæ, exteriores gradatim breviores, omnes plus minusve pilosæ, interiores pappum fere æquantes; receptaculum leviter convexum, dense paleaceo-setosum. *Flores* glabri; corollæ tubuloso-infundibularis lobis acutis; antherarum caudæ elongatæ, subintegræ. *Achænia* glabra, crassa, subtetragona; pappi setæ uniseriatæ, longe plumosæ.

Shan hills at 5000 feet.

A very distinct species with foliage similar to that of *S. affinis*, but altogether more robust in habit and very different in the racemose-paniculate inflorescence.

Tricholepis Stictophyllum, *Clarke*; *Fl. Brit. Ind.* iii. p. 382; syn. Stictophyllum glabrum, *Edgw.*—Shan hills plateau at 5000 feet.

North-west India at Garhwal, and the Subsivalik hills in the province of Saharunpore.

Leucomeris decora, *Kurz, Forest Fl. Burma*, ii. p. 78; *Fl. Brit. Ind.* iii. p. 387.—Shan hills at 2000 to 5000 feet. Also collected by Mr. Aplin.

Forests of Prome.

Ainsliæa pteropoda, *DC.*; *Fl. Brit. Ind.* iii. p. 388.—Shan hills at 6000 feet.

Northern and Eastern India to Tenasserim and Western China.

Gerbera piloselloides, *Cass.*; *Fl. Brit. Ind.* iii. p. 389.—Shan hills at 4000 feet.

Mountains of North India, eastward to Hongkong; also found in Madagascar and in Eastern Africa, southward to Cape Colony.

Picris hieracioides, *Linn.*; *Fl. Brit. Ind.* iii. p. 393.—Shan hills plateau at 5000 feet.

Western Europe and North Africa to China and Japan; also

in Australia, New Zealand, and in North America, where, however, it may have been introduced.

Crepis japonica, *Benth.*; *Fl. Brit. Ind.* iii. p. 395.—Shan hills plateau at 5000 feet.

Afghanistan eastward to Japan and southward to Australia; also in Mauritius and South Africa, where it may have been introduced.

Crepis acaulis, *Hook. f. in Fl. Brit. Ind.* iii. p. 396.—Shan hills at 3000 feet.

Very widely spread in India.

Crepis (§ Youngia) subscaposa, *Coll. et Hemsl.*, n. sp.

Herba biennis? hispidula, pilis simplicibus, 9–18 poll. alta, caulibus aphyllis gracilibus superne pauciramosis. *Folia* rosulata, crassiuscula, obovato-oblonga vel spathulata, in petiolum brevem attenuata, 2–3 poll. longa, apice rotundata, pauci calloso-denticulata, utrinque hispidula. *Capitula* pauca, circiter 5–7, corymbosa, longe pedunculata, 6–8 lineas diametro, circiter 30-flora; involucri calyculati bracteæ hispidulæ, intimæ uniseriatæ, lineari-oblongæ, obtusæ, marginibus scariosæ, pappum triente breviores; receptaculum parvum, nudum; ligulæ breves, brevissime calloso 5-dentatæ, extus infra medium puberulæ; antheræ basi breviter setaceo-caudatæ. *Achænia* recta, subcompressa, gracilia, pluricostata, nuda, supra medium hispidula, sursum attenuata, pappo longiora; pappi setæ albæ, molles, uniseriatæ, simplices, in annulum deciduæ.

Shan hills at 3000 to 5000 feet.

Not closely allied to any species, and in habit resembling some of the small-headed *Hieracia*.

Crepis (§ Youngia) chloroclada, *Coll. et Hemsl.*, n. sp.

Herba perennis, 12–20 poll. alta, a basi multiramosa, fere undique glabra, caulibus ramisque gracilibus rigidis lignescentibus angulatis viridibus. *Folia* radicalia non visa, caulina coriacea, glabra, linearia, 1–1½ poll. longa, vel interdum ad bracteas breves subulatas reducta. *Capitula* angusta, 7–10-flora, longe graciliterque pedunculata; involucri calyculati bracteæ circiter 7, lineari-oblongæ, obtusæ, dorso hispidulæ;

receptaculum parvum, nudum; ligulæ 5-dentatæ. *Achænia* minuta, fusiformia, glabra, leviter pauci-costata, apice constricta; pappi setæ albæ, molles, fere obsoletæ, scaberulæ, quam achænia duplo longiores.

Shan hills at 4000 feet.

This very closely resembles *C. glauca*, Hook. f. (Fl. Brit. Ind. iii. p. 394), not of Torrey and Gray, a native of North-west India, described as an annual, though some of the specimens seem to indicate a plant of longer duration. *C. chloroclada* differs in the hairy involucre and relatively much shorter achenes, constricted at the top, and having fewer, less conspicuous ribs.

Lactuca polycephala, *Benth.*; *Fl. Brit. Ind.* iii. p. 410.—Shan hills plateau at 5000 feet.

Afghanistan to Khasia and Burma.

Lactuca gracilis, *DC.*; *Fl. Brit. Ind.* iii. p. 410.—Shan hills at 4000 to 5000 feet.

Nepal to Central China.

Lactuca sagittarioides, *Clarke*; *Fl. Brit. Ind.* iii. p. 410.—Shan hills at 5000 feet.

Western Himalaya to Upper Burma.

Lactuca alatipes, *Coll. et Hemsl.*, n. sp.

Herba robusta, glabrescens, caulibus crassiusculis lævibus. *Folia* caulina inferiora membranacea, longissime petiolata, petiolo alato, trilobata, usque ad 14 poll. longa, lobo terminali amplo sagitto-hastato obscure multilobato simul remote calloso-denticulato, lobis lateralibus terminali distantibus parvis vix pollicaribus rotundatis. *Capitula* laxe paniculata (ramulis pedunculisque squamoso-bracteatis gracilibus), erecta, circiter 9-flora; involucri calyculati bracteæ circiter 9, uniseriatæ, glabræ, lineari-oblongæ, semipollicares, obtusæ. *Achænia* rubescentia, angusta, valde compressa, faciebus prominenter 4–5-costatis, ceterum lævia vel minutissime setulosa, longe gradatimque rostrata, circiter 3 lineas longa; pappi setæ numerosissimæ, albæ, molles, minutissime setulosæ, achænia triente longiores.

Shan hills terai at 3000 feet.

Apparently a very distinct species similar to *L. hastata*, DC.

Campanulaceæ.

Pratia begonifolia, *Lindl.*; *Fl. Brit. Ind.* iii. p. 422.—Shan hills at 3000 feet.

Widely spread in Eastern India and Malaya, and extending to Southern China.

Lobelia rosea, *Wall.*; *Fl. Brit. Ind.* iii. p. 427.—Shan States, *Manders.*

North India, from Kumaon eastward to Khasia and southward to Martaban.

Wahlenbergia gracilis, *A. DC.*; *Fl. Brit. Ind.* iii. p. 429.—Shan hills plateau at 5000 feet.

Common throughout India, Eastern Asia and Australia, and also found in New Zealand and South Africa.

Codonopsis convolvulacea, *Kurz*; *Journ. Linn. Soc.* xxvi. p. 5.—Shan hills at 4000 to 5000 feet; common in grass, round the culms of which it twines.

Yunnan.

Campanumœa javanica, *Blume*; *Fl. Brit. Ind.* iii. p. 435.—Shan hills at 4000 feet.

Southward to Java and eastward to Japan.

Campanula cana, *Wall.*; *Fl. Brit. Ind.* iii. p. 440.—Shan hills at 5000 feet.

North Iudia, from Kumaon to Mishmi.

Adenophora khasiana, *Coll. et Hemsl.*; syn. Campanula khasiana, *Hook. f. et Thoms.*; *Fl. Brit. Ind.* iii. p. 439.—Shan hills.

Common in the Khasia mountains.

Professor Oliver had indicated in the Kew Herbarium that this is an *Adenophora* rather than a *Campanula*.

Vacciniaceæ.

Agapetes setigera, *D. Don*; *Fl. Brit. Ind.* iii. p. 443.—Shan hills at 6000 feet.

Khasia hills southward to Tavoy.

Vaccinium exaristatum, *Kurz, Forest Fl. Burma*, ii. p. 91.—Shan hills at 4000 to 6000 feet.

Martaban.

Plumbagineæ.

Ceratostigma plumbaginoides, *Bunge*; *Journ. Linn. Soc.* xxvi. p. 36.—Shan hills at 5000 to 6000 feet.

Eastward to Eastern China, northward to Peking.

Not previously recorded west of China, and rare in the Shan hills, where it was only observed at Toongyi, near Fort Stedman.

Primulaceæ.

Primula Forbesii, *Franchet*; *Journ. Linn. Soc.* xxvi. p. 38.—Shan hills at 3000 to 3500 feet.

Yunnan.

This belongs to Franchet's new section *Monocarpicæ* of *Primula*, which furnishes a connecting-link between this genus and *Androsace*. It is very common in damp shady localities all over the Shan States.

Primula denticulata, *Smith*; *Fl. Brit. Ind.* iii. p. 485.—Shan hills plateau at 5000 feet.

Afghanistan to Western China.

Lysimachia lobelioides, *Wall.*; *Fl. Brit. Ind.* iii. p. 502.—Shan hills at 5000 feet.

North India, from Kashmir eastward, and in Java.

Lysimachia chenopodioides, *Watt*; *Fl. Brit. Ind.* iii. p. 503.—Shan hills terai at 2000 feet.

Kashmir to Bhotan, though not hitherto found in Sikkim.

Myrsineæ.

Mæsa ramentacea, *A. DC.*; *Fl. Brit. Ind.* iii. p. 508; *Forest Fl. Burma*, ii. p. 99.—Shan hills terai at 3000 feet; also collected by Mr. Aplin.

Eastern India and Malaya.

Mæsa indica, *Roxb.*; *Fl. Brit. Ind.* iii. p. 509; *Forest Fl. Burma*, ii. p. 99.—Shan hills at 4000 feet.

Throughout India and Malaya, and the same, or a very closely allied species, is found in Africa and Madagascar.

Mæsa mollis, *A. DC.*; *Fl. Brit. Ind.* iii. p. 510; syn. M. mollissima, *Kurz*, *Forest Fl. Burma*, ii. p. 100, *non A. DC.*—Shan hills plateau at 4000 feet.

Pegu, Tenasserim, and Java.

Embelia Ribes, *Burm.*; *Fl. Brit. Ind.* iii. p. 513; *Forest Fl. Burma*, ii. p. 101.—Shan hills at 3000 to 5000 feet.

Widely spread in India and Malaya, and extending to South-eastern China.

Embelia furfuracea, *Coll. et Hemsl.*, n. sp.

Frutex ramis crassiusculis ferrugineo-furfuraceis, ramulis lateralibus circiter pollicaribus rigidis 2–3-foliatis floriferis etiam ferrugineis. *Folia* (juniora tantum visa) petiolata, crassiuscula, papyracea, anguste obovata vel oblanceolata, cum petiolo usque ad 2 poll. longa, apice rotundata, deorsum attenuata, integra, utrinque pubescentia, venis inconspicuis. *Flores* (♂ tantum visi) minuti, puberuli, in racemos simplices axillares pollicares vel sesquipollicares amentiformes dispositi, brevissime pedicellati vel sessiles, nigro-punctati; calycis lobi breves, deltoidei, subacuti; petala libera, leviter imbricata, lanceolata, obtusa; antheræ magnæ, fere sessiles, dorso secus connectivum nigro-punctatæ.

Shan hills at 5000 feet.

This is so like *Antidesma fruticulosum*, Kurz, in general appearance, that it was taken for an *Antidesma* before the flowers were examined.

Ardisia polycephala, *Wall.*; *Fl. Brit. Ind.* iii. p. 529; *Forest Fl. Burma*, ii. p. 109.—Shan hills at 4000 feet.

Pegu and Tenasserim.

A specimen collected at an altitude of 2000 feet, and having fewer-flowered racemes on longer peduncles, may belong to this species.

Sapotaceæ.

Sideroxylon burmanicum, *Coll. et Hemsl.*, n. sp.

S. assamico et *S. Hookeri* affinis, differt foliis pallidis latioribus venis primariis lateralibus paucioribus inconspicuis, floribus

paullo majoribus, corollæ tubo longiore staminodiis minus fimbriatis.

Shan hills at 3000 to 4000 feet.

This and the two species named are very closely allied in floral structure, but in foliage this differs from both in the inconspicuous venation, and from the former in being glabrous.

Bassia longifolia, *Linn.*, var.?; *Fl. Brit. Ind.* iii. p. 544.—Shan hills.

This differs from typical *B. longifolia*, which is recorded from the Deccan peninsula, Ceylon, and Bengal (Beddome), in having smaller flowers and hairless stamens, but it may be a depauperated condition. There is a specimen in the Kew Herbarium of what we take to be the *B. longifolia* from Singapore.

Mimusops Elengi, *Linn.*; *Fl. Brit. Ind.* iii. p. 548; *Forest Fl. Burma*, ii. p. 123.—Shan hills.

South India and Malay peninsula.

Ebenaceæ.

Diospyros montana, *Roxb.*; *Fl. Brit. Ind.* iii. p. 555.—Shan hills at 2000 feet.

Widely spread in India and Malaya, and extending to tropical Australia.

Diospyros, sp. n.? aff. *D. sylvaticæ.* Specimen mancum.—Shan hills terai at 2000 feet.

Styraceæ.

Symplocos cratægoides, *Ham.*; *Fl. Brit. Ind.* iii. p. 573; *Forest Fl. Burma*, ii. p. 147.—Shan hills at 5000 feet.

North India, from Kashmir eastward to Japan, and southward through Burma to Martaban.

Symplocos racemosa, *Roxb.*; *Fl. Brit. Ind.* iii. p. 576; *Forest Fl. Burma*, ii. p. 144.—Shan hills at 3000 feet, *Aplin* and *Manders.*

Eastern India, Burma, and South-eastern China.

Styrax rugosum, *Kurz, Forest Fl. Burma*, ii. p. 141; *Fl. Brit. Ind.* iii. p. 589.—Shan hills at 4000 feet.

Martaban.

Oleaceæ.

Jasminum Roxburghianum, *Wall.*; *Fl. Brit. Ind.* ii. p. 595.—Shan hills at 1000 to 4000 feet.

South India, and it was also collected by Griffith in Ava, though it was not included from this locality in the 'Flora of British India.'

Jasminum anastomosans, *Wall.*; *Fl. Brit. Ind.* iii. p. 596; *Forest Fl. Burma*, ii. p. 152.—Shan hills terai at 2500 feet.

Eastern India and southward to Tenasserim.

Jasminum rigidum, *Zenker*; *Fl. Brit. Ind.* iii. p. 598.—Shan hills at 4000 feet.

South India and Ceylon.

Schrebera swietenioides, *Roxb.*; *Fl. Brit. Ind.* iii. p. 604; *Forest Fl. Burma*, ii. p. 156.—Shan hills terai at 2500 feet.

Subtropical North India, from Kumaon eastward, and southward into the Deccan peninsula, Pegu, and Martaban.

Fraxinus floribunda, *Wall.*; *Fl. Brit. Ind.* iii. p. 605.—Shan hills at 4000 feet.

North India, from Kashmir to Khasia.

Linociera caudata, *Coll. et Hemsl.*, n. sp.

L. malabaricæ affinis, differt foliis minus coriaceis caudato-acuminatis, floribus paniculatis fere glabris.

Shan hills terai at 3000 feet.

This has the caudate petals of *L. malabarica*, Wall., but the flowers are panicled instead of the peduncles being fascicled or at most three- or four-flowered. *L. terniflora*, Wall., differs in having smaller flowers and much shorter petals.

Ligustrum nepalense, *Wall.*; *Fl. Brit. Ind.* iii. p. 617.—Shan hills at 4000 to 5000 feet.

North India, from Garhwal eastward.

Ligustrum robustum, *Blume*?; *Fl. Brit. Ind.* iii. p. 614.—Shan hills at 4000 feet.

Eastern India and Malaya.

The specimen has a remarkably elongated inflorescence, and the flowers are in very young bud.

SALVADORACEÆ.

Azima sarmentosa, *Benth. et Hook. f.*; *Fl. Brit. Ind.* iii. p. 620.—Meiktila.

Malaya and Philippines.

Kurz (Forest Fl. Burma, ii. p. 161) records *A. tetracantha*, Lam., a native of Western India and Africa, from Ava and Prome; but the species are still imperfectly defined, and from his description it is uncertain which he had in view.

This is an erect shrub, not a trailer or creeper as might be supposed from the specific name.

APOCYNACEÆ.

Rauwolfia peguana, *Hook. f.* ?; *Fl. Brit. Ind.* iii. p. 632.—Shan hills.

Pegu.

The Shan plant does not exactly agree with the imperfect original specimen of this species. There are also very young undeveloped specimens of a second species of *Rauwolfia*.

Holarrhena antidysenterica, *Wall.*; *Fl. Brit. Ind.* iii. p. 644; *Forest Fl. Burma*, ii. p. 182.—Shan hills at 1000 feet.

North India from the Chenab eastward, and southward to Malacca.

Vallaris Heynei, *Spreng.*; *Fl. Brit. Ind.* iii. p. 650; syn. Vallaris dichotoma, *Wall.*; *Forest Fl. Burma*, ii. p. 181.—Yemethen.

Widely spread in tropical India southward to Ceylon, Malacca, and Java, but commonly cultivated, and perhaps not wild over so wide an area as that indicated.

Wrightia tomentosa, *Rœm. et Schult.*; *Fl. Brit. Ind.* iii. p. 653; syn. W. mollissima, *Wall.*; *Forest Fl. Burma*, ii. p. 192.—Shan hills at 4000 feet.

Tropical India to Ceylon and Penang.

Wrightia coccinea, *Sims*?; *Fl. Brit. Ind.* iii. p. 654; *Forest Fl. Burma*, ii. p. 193.—Shan hills at 3500 feet.

Eastern India and the Philippine Islands.

Ichnocarpus frutescens, *R. Br.*; *Fl. Brit. Ind.* iii. p. 669; *Forest Fl. Burma*, ii. p. 185.—Shan hills.

Tropical India, Malaya, and North Australia.

Aganosma marginata, *G. Don*; *Fl. Brit. Ind.* iii. p. 663; *Forest Fl. Burma*, ii. p. 186.—Meiktila.

Eastern India and Malaya to the Philippine Islands.

Aganosma cymosa, *G. Don*, typica et *β*. **glabra**, *DC.*; *Fl. Brit. Ind.* iii. p. 665.—Shan hills at 2000 feet; *β. glabra* at 4000 feet.

Silhet and South India.

Trachelospermum fragrans, *Hook. f.*; *Fl. Brit. Ind.* iii. p. 667.—Shan hills at 4000 feet.

North India from Kumaon to Assam and Cachar.

Chonemorpha macrophylla, *G. Don*; *Fl. Brit. Ind.* iii. p. 661; *Forest Fl. Burma*, ii. p. 187.—Shan hills at 4000 feet.

Widely spread in India and Malaya.

Asclepiadeæ.

Cryptolepis Buchanani, *Rœm. et Schult.*; *Fl. Brit. Ind.* iv. p. 5; *Forest Fl. Burma*, ii. p. 199.—Meiktila.

Throughout India and Ceylon.

Atherolepis venosa, *Coll. et Hemsl.*, n. sp.

Frutex vel herba perennis, puberula, caulibus erectis gracilibus pedalibus teretibus simplicibus, internodiis folia æquantibus vel brevioribus. *Folia* brevissime petiolata, coriacea, oblonga (inferiora usque ad 4 poll. longa, superiora flores subtendentia circiter pollicaria), rotundata vel obtusa simul apiculata, utrinque leviter scabrida, subtus pallidiora, costa venisque pallidis conspicuis subtus elevatis. *Flores* 1½–2 lineas diametro, pedunculis brevissimis axillaribus dense squamoso-bracteatis 1–3-floris; calyx crassus, puberulus, lobis ovato-oblongis obtusis ciliolatis intus basi minute subulato-biglandulosis; corolla crassa, carnosa, subrotata, extus puberula, lobis ovato-oblongis rotundatis; coronæ squamæ 5, corniformes, stamina superantes; stamina glandulis vel squamis subglobosis alternantia; ovarium glabrum, semi-inferum. *Folliculi* ignoti.

Meiktila.

In floral characters this agrees almost exactly with *A. Wallichii*, Hook. f., the only other species known, which is erroneously described as having an eglandular calyx, for glands are present, although very minute. Thick conspicuously veined leaves characterize the present species.

Streptocaulon tomentosum, *Wight et Arnott*; *Fl. Brit. Ind.* iv. p. 10; *Forest Fl. Burma*, ii. p. 198.—Meiktila.

Burma to Tavoy, Yunnan, and Cochinchina.

Asclepias curassavica, *Linn.*; *Fl. Brit. Ind.* iv. p. 18.—Shan hills at 4400 feet.

A native of tropical America, now very widely colonized in the warm regions of the Old World.

Adelostemma gracillimum, *Hook. f.*; *Fl. Brit. Ind.* iv. p. 21.—Meiktila.

Previously only known from comparatively imperfect specimens from Segain, collected by Wallich.

Sarcostemma Brunonianum, *Wight et Arnott*; *Fl. Brit. Ind.* iv. p. 27.—Meiktila.

South India and Burma.

The proposed species of this genus are not very clearly defined.

Gymnema molle, *Wall.*; *Fl. Brit. Ind.* iv. p. 29.—Meiktila.

Previously known only from Wallich's specimens, collected near the petroleum-wells on the Irawaddi, and at Taongdong.

Gymnema acuminatum, *Wall.*; *Fl. Brit. Ind.* iv. p. 30; *Forest Fl. Burma*, ii. p. 202.—Shan hills at 4000 feet.

Eastern India and Malay peninsula.

Tylophora asthmatica, *Wight et Arnott*; *Fl. Brit. Ind.* iv. p. 44.—Meiktila.

Widely spread in India and Malaya.

There is an imperfect specimen of what may be a second species of this genus.

Marsdenia barbata, *Coll. et Hemsl.*, n. sp.

Frutex scandens, ramulis floriferis graciliusculis teretibus albido-pubescentibus, internodiis quam folia duplo longioribus. *Folia* longiuscule petiolata, papyracea vel subcoriacea, rhomboideo-

ovata, absque petiolo $2\frac{1}{2}$–3 poll. longa, acuta, basi rotundata, margine plus minusve undulata, utrinque præcipue subtus ferrugineo-pubescentia, subtus venis pubescentioribus atro-ferrugineis conspicue laxe reticulatis; petiolus gracilis, 9–12 lineas longus. *Flores* ut videtur purpurei, 3–4 lineas diametro, in cymas parvas circiter 10–12 floras axillares breviter pedunculatas petiolos æquantes dispositi, pedunculis pedicellisque pubescentibus; calycis pubescenti segmenta crassiuscula, orbicularia, concava, prope marginem tenuiora hyalina, ciliolata, quam corolla dimidio breviora; corolla crassa, subcarnosa, campanulato-urceolata, extus glabra, tubo intus longe denseque barbato, lobis latis obtusis contortis angustissime dextrorsum obtegentibus; coronæ squamæ duræ, fere crustaceæ; antheræ membrana magna inflexa terminatæ; ovaria glabra. *Folliculi* ignoti.

Meiktila.

In general appearance this closely resembles *M. lucida*, Edgew., which, however, has almost glabrous leaves with inconspicuous secondary venation, more numerous flowers, and ciliolate corolla-lobes.

Pergularia pallida, *Wight et Arnott*; *Fl. Brit. Ind.* iv. p. 38; *Forest Fl. Burma*, ii. p. 203.—Meiktila.

Widely spread in tropical North and Central India.

Physostelma carnosa, *Coll. et Hemsl.*, n. sp.

Frutex humilis, undique glabra, ramis floriferis crassis carnosis, internodiis brevissimis. *Folia* petiolata, carnosa, lineari-oblonga vel lineari-lanceolata, 3–$4\frac{1}{2}$ poll. longa, obtusiuscula, basi producta, rotundata, supra nitida, subtus pallidiora costa crassa elevata; petiolus crassus, 3–4 lineas longus. *Flores* circiter 9 lineas diametro, fasciculati vel subumbellati, fasciculis subsessilibus, pedicellis graciliusculis circiter pollicaribus; calycis minuti segmenta tenuia, oblonga, obtusissima; corolla tenuis, sphæroidea, inflata, extus glabra, intus minute papillosa, lobis brevibus deltoideis subobtusis; coronæ squamæ amplæ, carnosæ, basi valde productæ, rotundatæ vix recurvæ; ovaria glabra. *Folliculi* ignoti.

Shan hills at 6000 feet.

Characterized by narrow fleshy leaves borne on thick branches, and nearly sessile fascicles of almost spherical flowers with very broad thick coronal appendages.

Leptadenia reticulata, *Wight et Arnott*; *Fl. Brit. Ind.* iv. p. 63.—Meiktila.

Eastern Punjab to Ceylon, Burma, and Singapore.

Ceropegia nana, *Coll. et Hemsl.*, n. sp. (Plate XIII.)

C. pusilla simillima sed rhizomate elongata, foliis brevioribus latioribus erectis, floribus 2–2½ poll. longis, corollæ lobis proportione longioribus.

Shan hills at 6000 feet.

DESCRIPTION OF PLATE XIII.

A plant of *Ceropegia nana*, Coll. et Hemsl., natural size.

Fig. 1, calyx, 2, a sepal showing the glands at the base on the inside; 3, portion of corolla, showing revolute lobes; 4, andrœcium and corona; 5, coronal lobe from the inside. All enlarged.

Brachystelma edulis, *Coll. et Hemsl.*, n. sp. (Plate XIV.)

Herba perennis; rhizomate tuberosa globosa vel ovoidea siccitate usque ad 1 poll. diametro, caulibus monocarpicis erectis simplicibus gracillimis 2–4 poll. altis puberulis vel scabridis, internodiis brevissimis. *Folia* sessilia, carnosa, angustissima, usque ad 2 poll. longa, acuta, patentissima, venis immersis omnino obsoletis. *Flores* pauci, circiter 3 lineas longi, in racemum brevem terminalem dispositi, pedicellos graciles puberulos æquantes; calyx minutus, puberulus, lobis angustis acutis; corolla crassiuscula, subrotata, alte 5-fida, lobis angustis undulatis, intus pilis paucis albidis longissimis instructa; coronæ cupuliformis squamæ connatæ, antheras superantes, intus parce pilosæ, apice subæqualiter tridentatæ, dente intermedio inflexo. *Folliculi* gracillimi, 2¾–3¼ poll. longi, acuti, glabri; semina pauca, compressa, longe comosa, cum coma pollicaria.

Upper Burma at 900 feet.

A very distinct species, the exact counterpart in habit of *Ceropegia pusilla*, Wight.

Common on the sandy plains at Pyawbwe in Upper Burma. The fleshy root is sold as an article of food in the Bazar, and has a faint mawkish flavour. This little plant is singularly difficult of detection, as its leaves resemble those of the grasses among which it grows, and its small dull purple flowers do not catch the eye.

DESCRIPTION OF PLATE XIV.

A plant of *Brachystelma edulis*, Coll. et Hemsl., natural size.

Fig. 1, a bud; 2, corolla; 3, andrœcium and corona, with some of the coronal lobes turned down; 4, a pair of pollinia: all enlarged; 5, a pair of follicles, natural size; 6, a seed, enlarged.

Caralluma crenulata, *Wall.*; syn. Boucerosia crenulata, *Wight et Arnott*; *Fl. Brit. Ind.* iv. p. 77.—Pyawbwe, Upper Burma.

South India and Ava.

Loganiaceæ.

Buddleia asiatica, *Lour.*; *Fl. Brit. Ind.* iv. p. 82.—Shan hills terai at 2000 feet; also collected by Mr. Aplin.

Throughout India, and extending to Malaya, South-west China, Formosa, and Cochinchina.

Fagræa obovata, *Wall.*; *Fl. Brit. Ind.* iv. p. 83; *Forest Fl. Burma*, ii. p. 205.—Shan hills at 3000 feet.

Central and Eastern India to Ceylon, and the Malay peninsula to Singapore.

Strychnos Nux-vomica, *Linn.*; *Fl. Brit. Ind.* iv. p. 90; *Forest Fl. Burma*, ii. p. 166.—Shan hills at 3000 to 4000 feet.

Throughout tropical India.

Gentianaceæ.

Canscora diffusa, *R. Br.*; *Fl. Brit. Ind.* iv. p. 103.—Shan hills at 3000 feet, *Manders*.

India, Malaya, Australia, and East Africa.

Gentiana crassa, *Kurz*; *Fl. Brit. Ind.* iv. p. 114.—Shan hills, *Manders*.

Pegu and Moulmein.

Gentiana decemfida, *Hamilt.*; *Fl. Brit. Ind.* iv. p. 112.—Shan hills plateau at 5000 feet.

Northern India and China.

Gentiana pedicellata, *Wall.*; *Fl. Brit. Ind.* iv. p. 111; sub G. quadrifaria, *Blume*.—Shan hills plateau at 5000 feet.

North India and China.

We do not feel satisfied that this is correctly referred by Mr. C. B. Clarke to *G. quadrifaria*, Blume.

Swertia (§ Ophelia) striata, *Coll. et Hemsl.*, n. sp.

Herba annua, erecta, 15–18 poll. alta, glaberrima, caule anguste 4-alato infra medium simplici supra pyramidiformi-ramoso, ramulis gracilibus. *Folia* sessilia, crassiuscula, anguste lanceolata, 1–1½ poll. longa, subacuta, obscure 3-nervia. *Flores* 5-ameri, 10–12 lineas diametro, numerosi, laxe paniculati, longe graciliterque pedicellati; calycis segmenta fere libera, fere linearia, acuta, petalis vix triente breviora; corollæ rotatæ segmenta ovato-lanceolata, acuta, longitudinaliter pluri-striata, intus prope basin biglandulosa, simul squamis duabus longe fimbriatis supra glandulas impositis instructa; filamenta vix dilatata; ovarium sessile, multiovulatum, stigmate sessili bilobato.

Shan hills at 4000 feet.

Pentamerous flowers with striped petals bearing long fringed scales on the two glands near the base characterize this species.

Swertia (§ Ophelia) stricta, *Coll. et Hemsl.*, n. sp.

Herba annua, erecta, 9–15 poll. alta, gracilis, fere undique glaberrima, ramulis floriferis brevissimis supra medium exceptis caule simplici. *Folia* sessilia, crassiuscula, lineari-lanceolata, maxima vix 1 poll. longa, obtusa, ciliolata, supra minute hispidula. *Flores* 5-ameri, cærulei vel lilacini, 8–9 lineas diametro, in cymas parvas densas laterales terminalesque dispositi, pedicellis gracilibus quam flores brevioribus; calycis segmenta fere libera, crassiuscula, anguste lanceolata, acuta, quam corolla triente breviora, 1-costata, margine incrassata, ciliolata; corollæ rotatæ lobi lanceolati, acuti, intus basi obscure uniglandulosi, nudi; filamenta deorsum dilatata, basi pseudomonadelpha; ovarium sessile, glabrum, stylo bifido ramulis recurvis.

Shan hills at 4000 feet.

Not very closely allied to any species.

Limnanthemum cristatum, *Griseb.*; *Fl. Brit. Ind.* iv. p. 131.—Shan hills at 4000 feet.

Throughout India to South China and the Philippines.

Limnanthemum indicum, *Thwaites*; *Fl. Brit. Ind.* iv. p. 131. —**Shan hills at 8000 feet.**

India, Malaya, China, Fiji islands, Australia, and Mascarene islands.

Boraginaceæ.

Cordia Myxa, *Linn.*; *Fl. Brit. Ind.* iv. p. 136; *Forest Fl. Burma*, ii. p. 208.—Shan hills at 4000 feet.

Throughout India and Malaya to South China and North Australia.

Ehretia lævis, *Roxb.*, var.; *Fl. Brit. Ind.* iv. p. 141: *Forest Fl. Burma*, ii. p. 210.—Shan hills terai at 2000 feet.

Persia, and throughout India to South China, Polynesia, and Australia.

Ehretia Wallichiana, *Hook. f. et Thoms.*?; *Fl. Brit. Ind.* iv. p. 143.—Shan hills at 5000 feet.

Sikkim, Bhotan, and Khasia.

Ehretia obtusifolia, *Hochst.*; *Fl. Brit. Ind.* iv. p. 142.—Meiktila.

Abyssinia, Baluchistan, Punjab, and Scind.

Coldenia procumbens, *Linn.*; *Fl. Brit. Ind.* iv. p. 144.—Meiktila.

Tropical Asia, Africa, America, and Australia.

Heliotropium strigosum, *Willd.*; *Fl. Brit. Ind.* iv. p. 151.—Meiktila.

Western Asia, and throughout India, South China, and Malaya, southward to Australia.

Heliotropium ovalifolium, *Forsk.*; *Fl. Brit. Ind.* iv. p. 150.—Meiktila.

Tropical Asia, Africa, and Australia.

Trichodesma calycosum, *Coll. et Hemsl.*, n. sp.

Ex affinitate *T. khasiani* foliis omnibus oppositis calyce amplissimo nuculis latis marginatis. *Caulis* robustus, 3–4-pedalis, tetragonus, cinereo-hirsutus. *Folia* petiolata, papyracea vel subcoriacea, lanceolata, usque ad 6 poll. longa (4 superiora tantum visa), utrinque dense hirsuta, supra vix leviter hispida, subtus pallida, mollia. *Flores* laxe paniculati, longe pedicellati, paniculis hirsutis ad 8 poll. diametro; calyx hirsutus, 5-lobatus, fructifer vesiculiformis, valde accrescens usque ad sesquipoll.

diametro, lobis vix acutis; corollæ glabræ tubus cylindricus, circiter 3 lineas longus, limbus fere pollicem diametro, basi extus 10-foveolatus, intus 10-torulosus, lobis latis longe acuminatis leviter incurvis; filamenta brevissima; antheræ dorso villosæ. *Nuculæ* latæ, compressæ, oblique insertæ, circiter 3 lineas longæ, denticulato-marginatæ, ceterum nudæ.

Shan hills at 4000 feet.

Trichodesma khasianum, Clarke, to which this is most nearly allied, has larger thinner leaves studded with coarse tubercled hairs.

Cynoglossum furcatum, *Wall.* ?; *Fl. Brit. Ind.* iv. p. 155.—Shan hills at 3000 to 5000 feet.

Afghanistan, and in mountainous regions throughout India to Ceylon.

The Shan specimens have less leafy stems.

Onosma burmanica, *Coll. et Hemsl.*, n. sp.

Herba erecta, 1½–2 ped. alta, siccitate tota argenteo-strigosa, caulibus robustis rigidis infra simplicibus, inflorescentia laxe ramosa. *Folia* (radicalia desunt) sessilia, rigida, lanceolata, 1–1½ poll. longa, vix acuta, margine revoluta. *Flores*, ut videtur, atropurpurei, circiter semipollicares, laxe pseudoracemoso-paniculati, pedicellis flores fere æquantibus, bracteis angustis pedicellis brevioribus; calyx dense hispido-pilosus, segmentis fere linearibus acutis corollam fere æquantibus; corolla extus appresse puberula, anguste tubuloso-campanulata, breviter 5-dentata, dentibus deltoideis acutis erectis; stamina infra medium tubi corollæ affixa, filamentis filiformibus tuboque basi villosis, antheris elongatis circa stylum conniventibus. *Nuculæ* erectæ, ovoideæ, acutæ, circiter 1½ lin. longæ, parce tuberculatæ.

Shan hills at 4000 feet.

A distinct species and the first record of the genus east of Sikkim. This plant was only once met with, growing gregariously on a grassy hill-side on the road from Koni to Fort Stedman, by way of the Inleywa lake.

Convolvulaceæ.

Argyreia obtecta, *Clarke*; *Fl. Brit. Ind.* iv. p. 186.—Shan hills terai at 3000 feet.

Burma and Tenasserim.

Very near, if not the same as, *A. Championi*, Benth. (*Lettsomia Championi*, Benth. et Hook. f.), a native of Hongkong.

Argyreia pallida, *Choisy; DC. Prodr.* ix. p. 330.—Meiktila. Burma.

A handsome climber, common in the forests.

This and the next are not taken up in the 'Flora of British India,' and it was not previously represented in the Kew Herbarium.

Blinkworthia lycioides, *Choisy, Conv. Orient.* p. 48, t. 5, et *in DC. Prodr.* ix. p. 354. (Plate XV.).—Meiktila. A common bush in the dry forests, flowering in the rainy season, when it is very conspicuous from its numerous white wax-like flowers.

This genus was founded upon very imperfect material, collected by Wallich on the Irrawadi. The present specimens are complete, with the exception of ripe fruit, which Choisy describes as "bacca monosperma." The fruit is really baccate; but it is certainly sometimes 4-seeded. Assuming the fruit to be baccate, *Blinkworthia* differs from *Argyreia* and *Lettsomia* in having solitary flowers; from *Rivea* in having a 2-celled ovary; and from all three of these genera in not being of twining habit. The generic character, as given in Bentham and Hooker's 'Genera Plantarum' (ii. p. 869), should be modified as follows:—

Sepala ovali-oblonga vel fere orbicularia, subæqualia, sub fructu aucta, indurata, lignescentia. *Corolla* campanulata, apice integra, circiter 9 lineas longa. *Stamina* inclusa, æqualia, prope basin corollæ affixa, filamentis basi dilatatis granulatis. *Discus* cylindricus, ovarium includens. *Ovarium* 2-loculare, loculis 2-ovulatis; stylus filiformis, inclusus, stigmate 2-globoso. *Fructus* baccatus.—*Frutex* erectus, 3–4 ped. altus, ramis gracilibus elongatis; folia parva, oblonga, elliptica, subtus parce strigosa, pallida. *Flores* axillares, solitarii, involucrati, pedunculis quam folia brevioribus; involucri bracteæ 2–4 (sæpissime 4), crassiusculæ, obovato-oblongæ, quam sepala breviores.

DESCRIPTION OF PLATE XV.

Branches of *Blinkworthia lycioides*, Choisy, natural size.

Fig. 1, corolla laid open; 2, pistil. Enlarged.

Lettsomia aggregata, *Roxb.*; *Fl. Brit. Ind.* iv. p. 191; *Forest Fl. Burma*, ii. p. 216.—Shan hills at 4000 feet.

South India, Burma, and Tenasserim.

Lettsomia strigosa, *Roxb.*; *Fl. Brit. Ind.* iv. p. 193.—Shan hills at 5000 feet.

Bengal, Tenasserim, Java, and the Andamans.

Lettsomia longifolia, *Coll. et Hemsl.*, n. sp.

Frutex volubilis, parce strigosus, ramulis graciliusculis. *Folia* graciliter petiolata, papyracea, anguste oblongo-lanceolata, absque petiolo usque ad 8 poll. longa, acuminata, basi rotundata vel subcuneata, supra præter costam strigosam glabra, subtus pallidiora, undique parce strigosa, venis primariis paucis inconspicuis; petiolus 6–9 lineas longus. *Flores* in cymas parvas (2–5-floras) axillares breviter pedunculatas conspicue bracteatas dispositi; bracteæ foliaceæ, oblongo-lanceolatæ, 12–15 lineas longæ, obtusæ, atro-rubentes, subtus strigosæ; sepala fructifera oblongo-orbicularia, fere semipollicaria, rigida, atro-rubentia, glabra . . . . . *Fructus* baccatus, unicus examinatus 2-spermus; semina nigra, compressa, circiter 3 lineas diametro, glabra.

Shan hills terai at 2000 feet.

In general appearance this most nearly resembles *Lettsomia barbata*, Clarke, which, however, has long linear bracts.

We have followed Bentham and Hooker's 'Genera Plantarum' in retaining *Lettsomia*, though we believe it must eventually be again reduced to *Argyreia*.

Ipomœa barlerioides, *Benth. et Hook. f.*; *Fl. Brit. Ind.* iv. p. 201; syn. Aniseia barlerioides, *Choisy*.—Shan hills at 3000 to 4000 feet.

North-west India to Chota Nagpore and Courtallam in the Deccan peninsula; but hitherto not recorded from Eastern India.

Ipomœa campanulata, *Linn.*; *Fl. Brit. Ind.* iv. p. 211; *Forest Fl. Burma*, ii. p. 218.—Shan hills at 3000 feet.

Tropical India and Malaya.

Ipomœa chryseides, *Ker*; *Fl. Brit. Ind.* iv. p. 206.—Near Yemethen on railway embankment.

Throughout India and Malaya, and extending to South China, Eastern Australia, and tropical Africa.

Ipomœa cymosa, *Roem. et Schult.*; *Fl. Brit. Ind.* iv. p. 211.—Shan hills terai at 3000 feet.

Tropical Asia, Africa, and Australia.

Ipomœa dissecta, *Willd.*; *Fl. Brit. Ind.* iv. p. 200.—Near Meiktila.

Tropical Asia, Africa, and Australia.

Ipomœa eriocarpa, *R. Br.*; *Fl. Brit. Ind.* iv. p. 204.—Shan hills at 3000 feet.

Tropical Asia, Africa, and Australia, and extending into some extratropical regions, as Afghanistan. Also colonized in the West Indies.

Ipomœa obscura, *Ker*; *Fl. Brit. Ind.* iv. p. 207.—Meiktila, very common.

Widely spread in tropical Asia, and occurring in the Mascarene islands, East Africa, and Australia.

Ipomœa palmata, *Forsk.*; *Fl. Brit. Ind.* iv. p. 214.—Meiktila.

Throughout the tropics, and reaching some subtropical parts.

Ipomœa palmata, *Forsk.*, var.? **gracillima,** *Coll. et Hemsl.*—Glaberrima, gracillima, foliis pedato-lobatis segmentis angustis, pedunculis filiformibus elongatis, floribus quam in typo saltem dimidio minoribus.—Meiktila.

Ipomœa palmata, Forsk., is spread over the tropics of both hemispheres.

Ipomœa petaloidea, *Choisy*; *Fl. Brit. Ind.* iv. p. 212; syn. I. xanthantha, *Kurz, Forest Fl. Burma,* ii. p. 219, et I. Riedeliana, *Oliver, Hook. Ic. Pl.* t. 1424.—Shan hills at 3000 feet.

Eastern India and Malaya, and also recorded from North Oude.

Choisy (DC. Prodr. ix. p. 360) describes his *Ipomœa petaloidea,* of which *Convolvulus crispatus,* Wall. (Cat. 1403), was the type, as having "corolla rubra speciosa in lacinias 5 alte divisa"; whereas the corolla of Wallich's plant bearing this number in the set at the Linnean Society's rooms is entire and remarkably hairy on the outside. From Choisy's description of the leaves,

too, it would appear that he had a different plant before him, or possibly a mixture of the two.

Ipomœa petaloidea, *Choisy*, var.? foliis fere linearibus.—Shan hills at 4000 feet.

Ipomœa sepiaria, *Kœnig*; *Fl. Brit. Ind.* iv. p. 209.—Meiktila.

Throughout India and Malaya, and probably East Australia.

Ipomœa Turpethum, *R. Br.*; *Fl. Brit. Ind.* iv. p. 212; *Forest Fl. Burma*, ii. p. 218.—Meiktila and Yemethen, a variety with narrow lanceolate leaves.

Tropical Asia and Australia, the Mascarene islands, and Polynesia.

Ipomœa vitifolia, *Sweet*; *Fl. Brit. Ind.* iv. p. 213; *Forest Fl. Burma*, ii. p. 419.—Shan hills at 3000 feet.

Throughout tropical India and Malaya.

Ipomœa (§ Euipomœa) nana, *Coll. et Hemsl.*, n. sp.

Herba erecta vel adscendens, 6–12 poll. alta, undique strigoso-villosa, radice fusiformi, caulibus sæpius simplicibus robustiusculis, internodiis quam folia multo brevioribus. *Folia* simplicia, breviter petiolata vel subsessilia, crassiuscula, obovato-lanceolata vel anguste oblonga, 1½–2½ poll. longa, obtusa vel acuta, basi cuneata, integra, utrinque longe strigoso-villosa. *Flores* purpurei, axillares, solitarii, brevissime pedunculati, 2½–3 poll. longi, ut videtur suberecti; sepala parum inæqualia, anguste lanceolata, acuminata, 6–7 lineas longa, extus longe pilosa; corolla anguste tubuloso-campanulata, obscure lobata, extus longe parceque pilosa; stamina inæqualia, longe inclusa, infra medium corollæ affixa, filamentis infra medium dilatatis barbatis; ovarium glabrum, 2-loculare, loculis 2-ovulatis; stylus filiformis, stamina superans, stigmate bigloboso. *Fructus* ignotus.

Shan hills at 4000 feet; common on the grassy plateau.

Not very closely allied to any Asiatic species, though the flowers strongly resemble those of *I. popahensis*, Coll. et Hemsl., and *I. barlerioides*, Benth. et Hook. f.

Ipomœa (§ Euipomœa) popahensis, *Coll. et Hemsl.*, n. sp.

Herba gracillima, volubilis, parce strigillosa, caulibus fere filiformibus lignescentibus glabrescentibus, internodiis quam folia

multo brevioribus. *Folia* simplicia, integra, breviter petiolata, anguste oblongo-lanceolata vel fere linearia, $2\frac{1}{3}$–4 poll. longa, apiculata, utrinque plus minusve strigillosa. *Flores* purpurei, axillares, solitarii, breviter pedunculati, $1\frac{1}{2}$–2 poll. longi; sepala inæqualia, lineari-lanceolata, acuminata, 6–8 lineas longa, colorata, extus longe pilosa; corolla anguste tubuloso-campanulata, obscure lobata, extus longe parceque pilosa; stamina leviter inæqualia, inclusa, infra medium corollæ affixa, filamentis deorsum leviter dilatatis parce papillosis; ovarium glabrum, 2-loculare, loculis 2-ovulatis; stylus filiformis stamina vix superans, stigmate 2-globoso. *Fructus* glaber, circiter 3 lineas diametro, pericarpio tenui indehiscente?; semina ovoidea, nigra, glabra.

Popah hill, Upper Burma, in grass, at 4000 feet.

This differs from *I. nana* in its slender twining habit, long narrow leaves, smaller flowers, and slightly papillose filaments.

Calystegia hederacea, *Wall.*; *Fl. Brit. Ind.* iv. p. 217.—Shan hills at 5000 feet.

Afghanistan to China and Amurland, and southward to Penang.

Convolvulus sinuatodentatus, *Coll. et Hemsl.*, n. sp.

Herba perennis, pubescens, caulibus gracilibus prostratis, internodiis quam folia brevioribus. *Folia* petiolata, crassiuscula, cordato-oblonga, 6–12 lineas longa, subobtusa, sinuato-dentata, hispidula; petiolus gracilis, $1\frac{1}{2}$–3 lineas longus. *Flores* parvi (circiter 9 lineas longi?, corollæ marcidæ tantum visæ), axillares, solitarii, pedunculis pubescentibus folia æquantibus vel excedentibus medio sæpius bibracteolatis; sepala æqualia, crassa, pallida, extus pubescentia, late ovata, obtusa, circiter 3 lineas longa; corolla marcida extus hirsuta; stamina inclusa, filamentis filiformibus glabris; ovarium glabrum, 2-loculare, loculis 2-ovulatis; stylus inclusus, alte 2-fidus. *Fructus* deest.

Shan hills plateau at 5000 feet; common on dry rocky ground.

The specimens have a starved appearance, and may be those of a species ordinarily of larger dimensions than those given above.

Evolvulus alsinoides, *Linn.*; *Fl. Brit. Ind.* iv. p. 220.—Shan hills at 4000 feet.

Almost universally spread in tropical and subtropical countries.

Porana spectabilis, *Kurz*; *Forest Fl. Burma*, ii. p. 221; *Fl. Brit. Ind.* iv. p. 221.—Shan hills at 2000 to 3000 feet.

Martaban.

Porana racemosa, *Roxb.*; *Fl. Brit. Ind.* iv. p. 222.—Shan hills at 3000 feet.

North-west India southward through Burma to Martaban.

Dichondra repens, *Forst.*; *Benth. Fl. Austral.* iv. p. 438.—Shan hills at 5000 feet.

This plant is spread over nearly all tropical and subtropical countries, extending to Japan and New Zealand, South Africa to Socotra, and Chili to the southern United States; yet it has never been found within the limits of British India. Wallich collected it at Taong Dong in Burma.

Cuscuta reflexa, *Roxb.*; *Fl. Brit. Ind.* iv. p. 225.—Shan hills at 4000 feet.

Throughout India, Ceylon, and Malaya.

SOLANACEÆ.

Solanum torvum, *Swartz*; *Fl. Brit. Ind.* iv. p. 234.—Shan hills, *Aplin*.

Throughout India and Malaya, South China, the Philippine islands, and in tropical America.

SCROPHULARINEÆ.

Wightia gigantea, *Wall.*; *Fl. Brit. Ind.* iv. p. 257.—Shan hills east of Tapet, at 4000 feet, *Aplin*.

Central and Eastern Himalaya, and Muneypore.

Excellent flowering specimens of this tree, previously not known to inhabit Burma.

Mazus rugosus, *Lour.*; *Fl. Brit. Ind.* iv. p. 259.—Shan hills plateau at 5000 feet.

Afghanistan to China, Japan, and Java.

Lindenbergia philippensis, *Benth.*; *Fl. Brit. Ind.* iv. p. 261.—Meiktila.

Eastern India, Malaya, and China.

Lindenbergia macrostachya, *Benth.*; *Fl. Brit. Ind.* iv. p. 262.—Shan hills at 3000 to 4000 feet.

North-west India to Burma, Siam, and China.

Lindenbergia urticæfolia, *Lehm.*; *Fl. Brit. Ind.* iv. p. 262.—Shan hills at 6000 feet.

Afghanistan to Burma and the Deccan peninsula, but not hitherto found in Ceylon.

Limnophila hypericifolia, *Benth.*; *Fl. Brit. Ind.* iv. p. 269.—Shan hills at 4000 feet.

Throughout India.

Herpestis Monniera, *H. B. K.*; *Fl. Brit. Ind.* iv. p. 272.—Shan hills at 4000 feet.

Cosmopolitan in warm countries.

Vandellia erecta, *Benth.*; *Fl. Brit. Ind.* iv. p. 281.—Shan hills terai at 2000 feet.

Central Europe to China, Japan, Malaya, and Polynesia.

Vandellia cerastoides, *Coll. et Hemsl.*, n. sp.

Herba adscendens, glabra, ramosa, caulibus elongatis pedalibus gracillimis debilibus radicantibus, internodiis quam folia longioribus interdum multoties longioribus. *Folia* breviter petiolata, crassiuscula, ovato-oblonga vel interdum fere orbicularia, semper obtusa, maxima semipollicaria, integra vel obscurissime paucicrenata, venis immersis obsoletis. *Flores* vix semipollicares, axillares, solitarii, longe graciliterque pedunculati, pedunculis 1–1½ poll. longis; calycis segmenta fere libera, crassa, anguste lanceolata, acuta, 2–2½ lineas longa, ecostata; corolla angusta; stamina perfecta 4, antherarum loculis caudiculatis. *Capsula* ignota.

Shan hills at 4000 feet.

Bonnaya brachiata, *Link et Otto*; *Fl. Brit. Ind.* iv. p. 284.—Meiktila.

Throughout India and Malaya, and extending to China and the Philippine islands.

Alectra indica, *Benth.*; *Fl. Brit. Ind.* iv. p. 297.—Shan hills at 5000 feet.

North India, Burma, and Mauritius.

Buchnera cruciata, *Ham.*; *Fl. Brit. Ind.* iv. p. 298.—Shan hills at 3500 to 4000 feet.

India, Malaya, and China.

Striga Masuria, *Benth.*; *Fl. Brit. Ind.* iv. p. 300.—Shan hills at 4000 feet.

Eastern India, Malaya, China, and the Philippine islands.

Sopubia trifida, *Ham.*; *Fl. Brit. Ind.* iv. p. 302.—Shan hills at 5000 feet.

Throughout India, and perhaps also in Madagascar and Australia.

Pedicularis comptoniæfolia, *Franchet*; *Mél. Biol.* xii. p. 871, t. 5. f. 96.—Shan hills at 6000 feet.

Yunnan.

Pedicularis gracilis, *Wall.*, var. **khasyana**, *Hook. f. Fl. Brit. Ind.* iv. p. 307.—Shan hills at 5000 to 6000 feet.

Eastern India, and the typical form extending westward to Afghanistan.

Pedicularis Collettii, *Prain in Journ. As. Soc. Beng.* lviii. 2, p. 278.—Shan hills at 4000 feet.

Pedicularis corymbosa, *Prain in Journ. As. Soc. Beng.* lviii. 2, p. 277.—Shan hills at 4000 feet.

OROBANCHACEÆ.

Æginetia pedunculata, *Wall.*; *Fl. Brit. Ind.* iv. p. 320.—Meiktila.

Throughout India and extending to China, Cochinchina, Singapore, and Java.

LENTIBULARIÆ.

Utricularia flexuosa, *Vahl*; *Fl. Brit. Ind.* iv. p. 329.—Shan hills at 3000 feet.

India, China, Malaya, and North Australia.

Utricularia cærulea, *Linn.*; *Fl. Brit. Ind.* iv. p. 331.—Shan hills at 5000 feet.

South India and Ceylon.

GESNERACEÆ.

Rhynchoglossum obliquum, *Blume* *Fl. Brit. Ind.* iv. p. 367.—Shan hills at 2000 feet.

Malay peninsula and archipelago.

Didymocarpus (§ **Orthobœa**) **neurophylla**, *Coll. et Hemsl.*, n. sp.

Herba acaulis, scaposa, 3–4 poll. alta. *Folia* rosulata, crassissima, breviter petiolata, obovato-lanceolata, 2–5 poll. longa, grosse undulato-crenata, apice rotundata, basi subcuneata, supra glabrata, plana, subtus incana, costa venisque crassissimis insigniter elevatis, venis primariis utrinque circiter 6; petiolus crassissimus, ½–1 poll. longus, basi dense pulvinato-lanatus. *Scapi* plures, graciles, glabri, nudi, apice cymosi, cymis densiusculis circiter 10–12-floris, pedicellis quam flores brevioribus. *Flores* glabri, 5–6 lineas diametro; calyx parvus, crassiusculus, lobis leviter inæqualibus oblongis obtusissimis; corolla oblique breviterque campanulata, lobis latis rotundatis undulatis; stamina perfecta 2, inclusa, antheris amplissimis reniformibus conniventibus; ovarium glabrum, stylo curvato exserto. *Capsula* brevis, matura non visa.

Shan hills at 6000 feet.

Allied to *D. tomentosa*, Wight, the leaves of which are very hairy on both sides and the scape too.

Bignoniaceæ.

Heterophragma sulphureum, *Kurz, Forest Fl. Burma*, ii. p. 235; *Fl. Brit. Ind.* iv. p. 381.—Shan hills terai at 1000 feet.

Burma.

Heterophragma adenophyllum, *Seem.*; *Fl. Brit. Ind.* iv. p. 381; *Forest Fl. Burma*, ii. p. 236.—Shan hills, *Aplin*.

Assam eastward, Tenasserim and the Andamans.

Stereospermum chelonoides, *DC.*; *Fl. Brit. Ind.* iv. p. 382; *Forest Fl. Burma*, ii. p. 230.—Shan hills at 4000 feet.

Oude to Ceylon and Burma.

Tecoma ? bipinnata, *Coll. et Hemsl.*, n. sp.

Frutex vagans, ramulis floriferis crassiusculis glabris compressis. *Folia* bipinnata, longe petiolata, cum petiolo usque ad 8 poll. longa, rhachidibus primariis atque secundariis anguste alatis; pinnæ circiter 5, sæpius 5-foliolatæ; foliola opposita, tenuia, breviter petiolata vel sessilia, ovato-lanceolata, 6–18 lineas longa (foliolo terminali longiore), integra, acuta, utrinque puberula, venis primariis lateralibus utrinque 2–4 prope marginem inter se

anastomosantibus. *Flores* glabri, circiter $2\frac{1}{2}$ poll. longi, in racemos terminales longe pedunculatos folia æquantes dispositi, rhachide gracili nigra, pedicellis brevibus gracilibus; calyx tubuloso-campanulatus, breviter subirregulariterque 5-dentatus, 4–5 lineas longus; corolla angusta, oblique infundibularis, lobis latis brevibus; stamina longe inclusa, didynamia, infra medium corollæ inserta, antheris dorso puberulis, loculis divergentibus, filamentis deorsum leviter dilatatis papillosis; staminodium elongatum filiforme; ovarium glabrum, basi disco cupulato cinctum, stylo stamina superanti sed incluso. *Capsula* ignota.

Shan hills at 4000 feet.

In the absence of fruit we provisionally place this in *Tecoma*.

ACANTHACEÆ.

Thunbergia laurifolia, *Lindl.*; *Fl. Brit. Ind.* iv. p. 392; *Forest Fl. Burma*, ii. p. 240; syn. T. Harrisii, *Hook. Bot. Mag.* t. 4998.—Shan hills at 4000 feet, *Manders.*

Burma to Malacca and in the Andamans.

Nelsonia campestris, *R. Br.*; *Fl. Brit. Ind.* iv. p. 394.—Shan hills terai at 2000 feet.

Central and Eastern India to Ceylon, Australia, Africa, and America.

Hygrophila salicifolia, *Nees*; *Fl. Brit. Ind.* iv. p. 407.—Shan hills terai at 3000 feet.

Throughout India and Ceylon.

Dædalacanthus tetragonus, *T. Anders.*; *Fl. Brit. Ind.* iv. p. 420.—Shan hills at 3000 feet, *Manders.*

Burma.

Hemigraphis sp., specimen mancum.—Meiktila.

Strobilanthes scaber, *Nees*; *Fl. Brit. Ind.* iv. p. 446.—Shan hills terai at 2000 feet.

Bengal and Burma.

Strobilanthes auriculatus, *Nees*; *Fl. Brit. Ind.* iv. p. 453.—Shan hills at 5000 feet, and Popah.

Central India.

Strobilanthes imbricatus, *Nees*; *Fl. Brit. Ind.* iv. p. 455.—Shan hills at 4000 feet.

Burma to Tenasserim.

Strobilanthes monadelphus, *Nees*; *Fl. Brit. Ind.* iv. p. 457.—Shan hills at 4000 feet.

Eastern India and Burma.

Strobilanthes (§ Endopogon) connatus, *Coll. et Hemsl.*, n. sp. (Plate XVI.)

Herba erecta, caulibus rectis rigidis subtetragonis primum incanis dein glabrescentibus. *Folia* coriacea, late connata, lanceolata, usque ad 6 poll. longa, longe acuminata, integra, supra glabra, cystolithis numerosissimis insigniter conspersa, subtus incano-lanata. *Flores* speciosi, in racemos 2 poll. longos densos bracteatos axillares et terminales breviter pedunculatos dispositi, brevissime pedicellati; bracteæ pubescentes, ovatæ, vix acutæ, calyces subæquantes; sepala subæqualia, lineari-lanceolata, 8–9 lineas longa, acuta, extus pubescentia, intus strigillosa; corolla sesquipollicaris, abrupte curvata, e tubo gracili torto subite expansa, extus glabra, intus postice villosa, limbi lobis brevibus rotundatis; stamina perfecta 2, antica, vix exserta, antheris glabris approximatis, filamentis dilatatis, infra medium valde dilatatis longe barbatis; ovarium vertice pilosum, ovula in quoque loculo 2, stylo supra medium parce pilosulo. *Capsula* ignota.

Hills in Eastern Karenni at 2000 feet; very common in the dry forest-tracts.

Characterized by thick connate leaves and short dense axillary and terminal clusters of flowers. The tube of the corolla is twisted so as to bring the upper lip lowermost or in front, and the odd lobe uppermost.

DESCRIPTION OF PLATE XVI.

Portion of a plant of *Strobilanthes connatus*, Coll. et Hemsl., natural size.

Fig. 1, a flower from which the corolla has been removed, with the pair of bracteoles at the base; 2, corolla, showing the twist in the tube; 3, portion of corolla and stamens; 4, a stamen; 5, pistil with the style removed; 6, section of ovary; 7, an ovule or young seed. All enlarged.

Strobilanthes gregalis, *Coll. et Hemsl.*, n. sp.

Frutex erectus, ramosus, 1–2-pedalis, caulibus ramisque rigidis teretibus rectis. *Folia* brevissime petiolata, coriacea,

ovato-oblonga, circiter bipollicaria, obtusa vel obtusissima, integra, supra rugosa, glabra, subtus incano-lanata, venis primariis paucis elevatis. *Flores* . . . . in spicas densas terminales pedunculatas late bracteatas dispositi; spicæ 2–3 aggregatæ (sæpius unica terminalis cum duabus lateralibus ex axillis foliorum 2 superiorum), circiter 2 poll. longæ, pedunculos æquantes vel longiores; bracteæ rigide coriaceæ, vel fructiferæ fere lignosæ, arcte imbricatæ, late rotundato-ovatæ vel orbiculares, usque 6 lineas diametro, obtusæ, margine albo-lanatæ; calycis segmenta subæqualia, tenuiter coriacea, obovato-oblonga, 6–7 lineas longa, obtusissima, margine lanata. *Capsula* glabra, oblonga, subacuta, circiter semipollicaris, loculis 2-spermis; semina (matura non visa) discoidea, valde compressa.

Shan hills at 4000 feet, gregarious, covering a hill-side, and conspicuous in the distance from its dark leaves.

In inflorescence this most nearly resembles *S. callosa*, Nees, but the bracts are much thicker and the relatively small thick leaves are quite different.

Blepharis boerhaaviæfolia, *Pers.*; *Fl. Brit. Ind.* iv. p. 478.—Meiktila.

Burma, South India, Ceylon, and tropical Africa.

Barleria cristata, *Linn.*; *Fl. Brit. Ind.* iv. p. 488.—Shan hills and Popah.

Widely spread in India and Malaya, but often cultivated.

Barleria Prionitis, *Linn.*; *Fl. Brit. Ind.* iv. p. 482.—Meiktila; common everywhere.

Tropical Asia and Africa.

Asystasia Neesiana, *Nees*; *Fl. Brit. Ind.* iv. p. 496.—Shan hills.

Eastern India, Moulmein.

Eranthemum indicum, *Clarke*; *Fl. Brit. Ind.* iv. p. 497.—Lwelon; Shan hills at 3000 feet, *Manders.* "The jungle was largely composed of this, so that we had constantly to cut our way through."

Sikkim and Eastern India.

Cystacanthus insignis, *Clarke*; *Fl. Brit. Ind.* iv. p. 514.—Shan hills at 2000 feet.

Burma.

Lepidagathis fasciculata, *Nees*; *Fl. Brit. Ind.* iv. p. 522.—Shan hills terai at 2000 feet.

Widely spread in the warmer parts of India from the North-west Himalaya to Ceylon and Tenasserim.

Lepidagathis thymifolia, *Coll. et Hemsl.*, n. sp.

Herba vel suffrutex ramulis sterilibus gracilibus repentibus, ramulis floriferis erectis cum inflorescentia 1–2 poll. altis. *Folia* subsessilia, rigida, ovato-oblonga, elliptica, vel fere orbicularia, $1\frac{1}{2}$–3 lineas longa, vix apiculata, utrinque puberula, venis primariis utrinque 3–4 subtus sat conspicuis. *Spicæ* densissimæ, oblongæ, 6–18 lineas longæ; bracteæ rigidæ, lanceolatæ, aculeato-acuminatæ, trinerviæ, longe, præcipue secus marginem, pilosæ, quam flores vix dimidio breviores; sepala subæqualia, bracteis simillima sed minus rigida, corollæ tubum paullo excedentia; corolla 4–5 lineas longa, glabra, maculata, fauce retrorso-pilosa, labio superiore erecto rotundato emarginato, labio inferiore subæqualiter trilobato, lobis oblongis obtusissimis tubo paullo brevioribus; stamina 4, paullo infra faucem affixa, breviter exserta, filamentis vix dilatatis glabris, antheris ciliolatis; ovarium vertice pilosum, 2-loculare, loculis 2-ovulatis, stylo filiformi parce puberula. *Capsula* ignota.

Shan hills at 3000 feet, growing among grass.

It is possible that the habit of this plant has been considerably modified by the periodic fires to which the country is subjected, and that, under favourable conditions, it would attain larger dimensions.

Lepidagathis purpuricaulis, *Nees*?; *Fl. Brit. Ind.* iv. p. 519.—Upper Burma—specimen imperfect.

North and East India and Burma.

Justicia procumbens, *Linn.*; *Fl. Brit. Ind.* iv. p. 539.—Shan hills terai at 2000 feet.

Tropical India, Malaya, and Australia.

Justicia khasiana, *Clarke*?; *Fl. Brit. Ind.* iv. p. 537.—Popah hill at 5000 feet.

Eastern India.

Justicia Gendarussa, *Linn. f.*; *Fl. Brit. Ind.* iv. p. 532; *Forest Fl. Burma*, ii. p. 247.—Northern Shan hills at 4000 feet.

India, Malaya, and China; often cultivated.

Justicia decussata, *Roxb.*; *Fl. Brit. Ind.* iv. p. 532.—Shan hills terai at 3000 feet.

Pegu and Tenasserim.

Justicia (§ Calophanoides) neurantha, *Coll. et Hemsl.*, n. sp.

Herba? erecta, ramosa, ramulis floriferis gracilibus teretibus lignescentibus glabris, nodis leviter incrassatis. *Folia* breviter petiolata, crassiuscula, ovato-oblonga, 1–2 poll. longa, obtusa, basi cuneata, glabra vel minute parceque setulosa, venis primariis lateralibus utrinque 6–8 elevatis. *Flores* parvi, circiter 6–7 lineas longi, in cymas axillares breves densas subsessiles vel breviter pedunculatas dispositi; bracteæ lineares, pubescentes; calycis segmenta herbacea, crassiuscula, lanceolata, acuta, circiter 3 lineas longa, utrinque pubescentia, subconspicue venosa; corolla extus puberula; labium superius suberectum, rotundatum, emarginatum, longitudinaliter 5-nervosum vel 5-striatum, labium inferius inæqualiter 3-lobatum, e medio utrinque oblique nervosum, lobis rotundatis; stamina 2, breviter exserta, antherarum loculis valde inæqualibus, inferiore appendice alba sursum dilatata apice denticulata instructo, filamentis parum dilatatis glabris; ovarium vertice hirsutum, 2-loculare, loculis 2-ovulatis; stylus glaber, breviter exsertus. *Capsula* non visa.

Shan hills at 6000 feet.

Justicia (§ Calophanoides) vagans, *Coll. et Hemsl.*, n. sp.

Frutex vel herba robusta, supra frutices erectos 8–9-pedales vagans, ramulis floriferis elongatis teretibus striatis glabris internodiis quam folia sæpius duplo longioribus. *Folia* petiolata, membranacea, lanceolata, $2\frac{1}{2}$–$3\frac{1}{2}$ poll. longa, obtusiuscula, utrinque attenuata, parce minuteque setulosa vel strigillosa, subtus pallidiora, venis primariis lateralibus utrinque circiter 6 sat conspicuis. *Flores* parvi, circiter 6 lineas longi, in cymas axillares breves densas subsessiles dispositi; bracteæ lineari-oblongæ, pubescentes, calyce breviores; calycis segmenta æqualia, bracteis simillima; corolla pubescens, labio superiore rotundato emarginato, inferiore inæqualiter trilobato oblique costato, lobis æquilongis rotundatis; stamina 2, breviter exserta, antherarum loculis parum inæqualibus, inferiore appendice alba parva instructo, filamentis late dilatatis glabris; ovarium glabrum, 2-loculare, loculis 2-ovulatis; stylus puberulus. *Capsula* ignota.

Shan hills terai at 2500 feet.

In foliage and in floral characters this and *J. neurantha*, Coll. et Hemsl., are very similar, yet apart from habit and locality there are slight differences. *J. vagans* has broader bracts, less deeply divided calyx, broader filaments, &c.

Adhatoda vasica, *Nees*; *Fl. Brit. Ind.* iv. p. 540; syn. Justicia Adhatoda, *Linn.*; *Forest Fl. Burma,* ii. p. 248.—Shan hills at 3000 feet.

India, Malaya, and Cochinchina.

Rungia parviflora, *Nees*; *Fl. Brit. Ind.* iv. p. 550.—Shan hills at 4000 to 5000 feet.

North-west India to Ceylon and Pegu.

Dicliptera magnibracteata, *Coll. et Hemsl.*, n. sp.

Herba ut videtur diffusa, glabrescens, ramulis floriferis crassiusculis subtetragonis. *Folia* longe petiolata, crassa, subcoriacea, ovato-lanceolata, absque petiolo usque ad 4½ poll. longa, acuminata, vix acuta, basi cuneata, parce minuteque setulosa, supra rugulosa, grosse reticulata, subtus venis primariis lateralibus circiter 6 conspicuis. *Flores* vix pollicares, in cymas densas axillares breviter pedunculatas 1–2 poll. longas et latas dispositi, plures intra bracteas geminatas oppositas conniventes (involucra formantes) sessiles; bracteæ foliaceæ, sessiles, cordato-ovatæ vel cordato-oblongæ, circiter 9 lineas longæ, basi cordatæ vel truncatæ, apice obtusissimæ vel rotundatæ, infra parce setulosæ, supra glabræ, subnitidæ, margine longe ciliatæ; pseudoinvolucra breviter pedunculata; bracteolæ inter flores minutæ; calyx membranaceus, pubescens, circiter sesquilineam longus, æqualiter 5-lobatus, lobis acutis; corolla retrorso-pilosula, subæqualiter bilabiata, labia fere integra, tubum fere æquantia; stamina 2, breviter exserta; antheræ loculis muticis discretis unico multo altius affixo, filamentis parum dilatatis pilosulis; ovarium glabrum, biloculare, loculis biovulatis; stylus filiformis, glaber, stigmate bifido. *Capsula* ignota.

Shan hills terai at 3000 feet.

Near *D. riparia*, Clarke, and *D. zeylanica*, Nees, but in the former the bracts are attenuated downwards, and in the latter they are acuminate and apiculate.

Dicliptera bupleuroides, *Nees*; syn. D. Roxburghii, var. bupleuroides, *Clarke in Fl. Brit. Ind.* iv. p. 554.—Shan hills terai at 2000 feet.

Afghanistan and throughout India.

Peristrophe bicalyculata, *Nees*; *Fl. Brit. Ind.* iv. p. 554.—Meiktila.

Tropical Asia and Africa.

VERBENACEÆ.

Lantana indica, *Roxb.*; *Fl. Brit. Ind.* iv. p. 562.—Shan hills at 4000 feet, *Manders.*

Tropical Asia and Africa.

Priva leptostachya, *Juss.*; *Fl. Brit. Ind.* iv. p. 565.—Meiktila.

South India and Africa.

Callicarpa arborea, *Roxb.*; *Fl. Brit. Ind.* iv. p. 567; *Forest Fl. Burma*, ii. p. 274.—Shan hills at 4000 feet.

Kumaon to Assam, and southward to Singapore and Sumatra.

Tectona Hamiltoniana, *Wall.*; *Fl. Brit. Ind.* iv. p. 571; *Forest Fl. Burma*, ii. p. 259.—Meiktila.

Prome and Ava.

Premna latifolia, *Roxb.*; *Fl. Brit. Ind.* iv. p. 577.—Shan hills at 3000 feet.

Eastern side of South India and in Bengal.

Premna coriacea, *Clarke*; *Fl. Brit. Ind.* iv. p. 573.—Shan hills at 4000 feet.

South India and Sikkim to Khasia.

The Shan specimens have the broad leaves of the typical Deccan form.

Premna nana, *Coll. et Hemsl.*, n. sp.

Suffrutex vel herba perennis undique fere velutino-pubescens, caulibus simplicibus erectis 4–6 poll. altis lignescentibus, internodiis quam folia multoties brevioribus. *Folia* circiter 5–6 paria, breviter petiolata, crassiuscula, utrinque molliter pubescentia, oblonga, lanceolata, oblanceolata vel interdum fere ovata, maxima 5 poll. longa, obtusa vel subacuta, deorsum in petiolum brevem

attenuata, leviter crenato-dentata vel infra medium integra, venis primariis utrinque 7–9 sat conspicuis. *Flores* circiter 3 lineas longi, in cymam densam terminalem breviter pedunculatam et $1\frac{1}{2}$–2 poll. diametro dispositi, pedicellis pubescentibus quam flores brevioribus; calyx crassus, puberulus, simul minute lepidotus vel papillosus, urceolatus, subbilabiatus, lobis erectis leviter inæqualibus oblongis apice rotundatis; corolla bilabiata, fauce villosa, labiis extus puberulis; labium superum erectum, concavum; labium inferum fere æqualiter 3-lobatum; stamina breviter exserta; ovarium glabrum, stylo glabro stamina æquante. *Fructus* ovoideus, circiter 3 lineas longus, calyce parum aucto subtendus.

Shan hills at 3000 feet.

Nearest to *Premna herbacea*, Roxb., differing in the distinctly developed internodes, in the shape and indumentum of the leaves, in the larger size of the flowers, in the substance of the calyx, and in the shape of the fruit.

Gmelina arborea, *Linn.*; *Fl. Brit. Ind.* iv. p. 581; *Forest Fl. Burma*, ii. p. 264.—Shan States, *Aplin.*

North and South India, Ceylon, Malaya, and the Philippine islands.

Gmelina asiatica, *Linn.*; *Fl. Brit. Ind.* iv. p. 582.—Meiktila.

South India, Ceylon, and Burma, and cultivated in Bengal.

Vitex trifolia, *Linn.*; *Fl. Brit. Ind.* iv. p. 583; *Forest Fl. Burma*, ii. p. 270, *ut varietas* V. Agni-casti.—Shan States, *Aplin.*

India, Ceylon, Malaya, to Japan, the Philippines, and North Australia.

Vitex canescens, *Kurz, Forest Fl. Burma*, ii. p. 270; *Fl. Brit. Ind.* iv. p. 586.—Meiktila.

Assam to Ava and Pegu.

Vitex limonifolia, *Wall.*; *Fl. Brit. Ind.* iv. p. 584; *Forest Fl. Burma*, ii. p. 271; syn. V. alata, *Schauer*; *DC. Prodr.* xi. p. 685, non *Heyne.*—Meiktila; also collected by Mr. Aplin at Kolouboük camp

Ava and Tenasserim to Siam.

Vitex vestita, *Wall.*; *Fl. Brit. Ind.* iv. p. 587; *Forest Fl. Burma*, ii. p. 272.—Shan hills at 4000 feet.

Burma to Malacca, Sumatra, Java, and Borneo.

Clerodendron Siphonanthus, *R. Br.*; *Fl. Brit. Ind.* iv. p. 595. —Shan hills at 3000 feet.

Kumaon eastward to Assam and Tenasserim; also in the mountains of South India and Sumatra.

Clerodendron serratum, *Spreng.*; *Fl. Brit. Ind.* iv. p. 592; *Forest Fl. Burma*, ii. p. 267.—Shan hills at 4000 feet, *Manders*.

Widely spread in India and Malaya.

Clerodendron lasiocephalum, *Clarke*; *Fl. Brit. Ind.* iv. p. 594. —Shan States at Heho, *Aplin*.

Previously only known from specimens collected by W. Griffith in Mishmi.

Caryopteris paniculata, *Clarke*; *Fl. Brit. Ind.* iv. p. 597; syn. Clerodendron grata, *Kurz*, non *Wall.*, *Forest Fl. Burma*, ii. p. 268.—Shan hills plateau at 5000 feet.

Nepal to Mishmi and Ava.

Hymenopyramis brachiata, *Wall.*; *Fl. Brit. Ind.* iv. p. 598; *Forest Fl. Burma*, ii. p. 258.—Meiktila.

Burma and Pegu.

Symphorema involucratum, *Roxb.*; *Fl. Brit. Ind.* iv. p. 599; *Forest Fl. Burma*, ii. p. 254.—Shan hills terai at 3000 feet.

South India, Ceylon, Burma, and Pegu.

Sphenodesma pentandra, *Jack*; *Fl. Brit. Ind.* iv. p. 602; *Forest Fl. Burma*, ii. p. 255, sub Symphoremata.—Shan hills terai at 2000 feet.

Eastern India and Malay peninsula.

Congea tomentosa, *Roxb.*; *Fl. Brit. Ind.* iv. p. 603; *Forest Fl. Burma*, ii. p. 256.—Shan hills at 2000 to 3000 feet.

Chittagong to Siam.

Labiatæ.

Ocimum sanctum, *Linn.*; *Fl. Brit. Ind.* iv. p. 609.—Meiktila.

Generally spread in the warmer parts of Asia and extending to Australia and Polynesia, but commonly cultivated.

Ocimum exsul, *Coll. et Hemsl.*, n. sp.

Herba, ut videtur, perennis *O. striato* (species Africæ tropicæ incola) simillima, caulibus erectis simplicibus hispidulis, internodiis quam folia brevioribus. *Folia* breviter petiolata, crassiuscula, hispidula, vel supra glabra, anguste obovato-lanceolata, 15–18 lineas longa, obtusa, remote obscurissimeque dentata, subtus pallidiora, venis primariis lateralibus obliquis utrinque circiter 7 elevatis. *Flores* absque staminibus circiter semipollicares, laxiuscule racemosi, racemis bracteis paucis parvis coloratis terminatis, verticillastris 4–6-floris, pedicellis brevibus bracteis squamæformibus instructis; calyx fructifer auctus, siccus, rigidiusculus, conspicue venosus, lobo postico orbiculato leviter recurvo, breviter decurrente, dentibus 2 anticis approximatis aristatis; corolla puberula; stamina longissime exserta, filamentis omnibus nudis; stylus longissime exsertus, alte bifidus. *Nuculæ* læves, pallidæ.

Meiktila.

Quite different from any of the Asiatic species of *Ocimum*, but closely resembling some of the African, especially *O. striatum*, and almost identical with specimens of this collected by Schweinfurth in Central Africa.

Dr. Prain, the Curator of the Calcutta herbarium, who has examined this plant, would refer it to *Orthosiphon*, because he found a "clavate-capitate hardly cleft stigma"; but on re-examining flowers we find a deeply bifid style, with slender arms. There is indeed little to separate these genera, and the character in question may not be constant.

It was noted in the living plant that the stamens, when they had shed their pollen, rolled themselves up and disappeared in the corolla-tube.

Orthosiphon rubicundus, *Benth.*; *Fl. Brit. Ind.* iv. p. 614.—Shan hills at 4000 feet.

Western subtropical Himalaya to the Circars and Nilghiris, and in Burma.

Orthosiphon stamineus, *Benth.*; *Fl. Brit. Ind.* iv. p. 615.—Shan hills terai at 2000 feet.

South India, Malay peninsula and archipelago, Philippine islands and Australia.

Plectranthus striatus, *Benth.*; *Fl. Brit. Ind.* iv. p. 618.—Shan hills at 4000 feet.

North India, from Kashmir to Khasia.

Plectranthus hispidus, *Benth.*; *Fl. Brit. Ind.* iv. p. 618.—Popah hill at 5000 feet.

Eastern India, on the Khasia mountains.

Plectranthus ternifolius, *D. Don*; *Fl. Brit. Ind.* iv. p. 621.—Shan hills at 5000 feet.

Kashmir to Behar, Khasia and South China.

Plectranthus Coetsa, *Ham.*; *Fl. Brit. Ind.* iv. p. 619.—Shan hills at 4000 feet.

North India, from Murree to Mishmi and Burma, and in South India.

P. menthoides, Benth., is hardly distinguishable.

Plectranthus sp., aff. P. Parishii, *Hook. f.*; *Fl. Brit. Ind.* iv. p. 622.—Shan hills at 4000 feet.

The specimen probably represents an undescribed species, but it is hardly sufficient for description.

Coleus spicatus, *Benth.*; *Fl. Brit. Ind.* iv. p. 624.—Shan hills at 3000 feet.

South India.

Anisochilus pallidus, *Wall.*; *Fl. Brit. Ind.* iv. p. 629.—Shan hills at 3000 feet.

Sikkim to Burma.

Anisochilus carnosus, *Wall.*; *Fl. Brit. Ind.* iv. p. 627.—Shan hills at 3000 feet.

Throughout India.

Pogostemon plectranthoides, *Desf.*; *Fl. Brit. Ind.* iv. p. 632. —Popah hill at 4000 feet.

Throughout India.

Pogostemon glaber, *Benth.*; *Fl. Brit. Ind.* iv. p. 633.—Shan hills terai at 3000 feet.

Nepal, Sikkim, and Khasia.

Dysophylla communis, *Coll. et Hemsl.*, n. sp.

Herba pauciramosa, puberula, ramulis tetragonis stramineis, internodiis quam folia sæpissime brevioribus. *Folia* opposita, membranacea, oblonga, usque ad 3½ poll. longa, obtusa, basi in petiolum longum pseudo-alatum attenuata, grosse crenata, utrinque pilis albis flaccidis parcissime conspersa, subtus pallidiora, venis primariis utrinque sæpius 4 sat conspicuis. *Flores* rosei, in spicas densissimas cylindricas terminales 1–3½ poll. longas subsessiles dispositi, absque staminibus exsertis 1½–2 lineas longi, pilosi; calyx cylindricus, puberulus, æqualiter 5-dentatus, corollæ tubum æquans; corolla extus pilosa; stamina breviter exserta, filamentis glabris. *Nuculæ* non visæ.

Shan hills at 4000 feet, very common.

This approaches *D. auricularia*, Blume, which is easily distinguished by the thicker substance of the leaves and by being densely villous all over.

Colebrookia oppositifolia, *Smith*; *Fl. Brit. Ind.* iv. p. 642; *Forest Fl. Burma*, ii. p. 277.—Shan hills terai at 2000 feet.

Central, Eastern, and Southern India and Tenasserim.

Elsholtzia Griffithii, *Hook. f.*; *Fl. Brit. Ind.* iv. p. 644.—Shan hills at 5000 feet.

Upper Assam.

The Shan-hills specimens are almost perfectly glabrous, but they do not otherwise differ.

Elsholtzia Beddomei, *Clarke*; *Fl. Brit. Ind.* iv. p. 643.—Shan hills at 5000 feet.

Tenasserim.

Elsholtzia blanda, *Benth.*; *Fl. Brit. Ind.* iv. p. 643.—Shan hills at 5000 feet.

Nepal to Khasia, Tenasserim, and Sumatra.

Elsholtzia cristata, *Willd.*; *Fl. Brit. Ind.* iv. p. 645.—Shan hills at 3000 feet.

Widely spread in India and extending to China and Japan, and long colonized in North Europe and Central Asia.

Mentha arvensis, *Linn.*; *Fl. Brit. Ind.* iv. p. 648.—Shan hills at 4000 feet.

Widely spread in Europe and Asia, and naturalized in North America and elsewhere.

Lycopus europæus, *Linn.*; *Fl. Brit. Ind.* iv. p. 648.—Shan hills at 4000 feet.

Widely spread in Europe and Asia, and the Australian *L. australis*, R. Br., is perhaps not specifically different. The Shan specimens have almost entire leaves, and the whole aspect of the plant is very different from ordinary *L. europæus*.

Micromeria biflora, *Benth.*; *Fl. Brit. Ind.* iv. p. 650.—Shan hills at 4000 to 6000 feet.

Arabia to the mountains of Northern and Southern India and Burma; also in Abyssinia and South Africa.

Both glabrous and hairy varieties occur in the Shan hills.

Salvia plebeia, *R. Br.*; *Fl. Brit. Ind.* iv. p. 655.—Shan hills at 5000 feet.

India, Malaya, China, and Australia.

Scutellaria rivularis, *Wall.*; *Fl. Brit. Ind.* iv. p. 670.—Shan hills at 5000 feet.

North and South India, Burma, and China.

Scutellaria repens, *Ham.*; *Fl. Brit. Ind.* iv. p. 669.—Shan hills at 5000 feet.

Kashmir to Sikkim and Ava.

Scutellaria glandulosa, *Hook. f.*; *Fl. Brit. Ind.* iv. p. 669.—Shan hills at 4000 feet.

Burma.

Anisomeles ovata, *R. Br.*; *Fl. Brit. Ind.* iv. p. 672.—Shan hills at 4000 feet.

India, Ceylon, Malaya, China, and the Philippines.

Anisomeles candicans, *Benth.*; *Fl. Brit. Ind.* iv. p. 673.—Shan hills terai, in dry forest at 1000 feet.

Burma.

A variety having the axes of the cymes remarkably elongated.

Achyrospermum Wallichianum, *Benth.*; *Fl. Brit. Ind.* iv. p. 673.—Shan hills at 4000 feet.

Eastern India and Tenasserim.

Colquhounia elegans, *Wall.*; *Fl. Brit. Ind.* iv. p. 674; *Forest Fl. Burma*, ii. p. 278.—Shan hills at 4000 feet.

Burma.

Colquhounia vestita, *Wall.*; *Fl. Brit. Ind.* iv. p. 674.—Shan hills at 4000 feet.

North India, from Kumaon to Khasia and Mishmi.

Leonurus sibiricus, *Linn.*; *Fl. Brit. Ind.* iv. p. 678.—Shan hills at 4000 feet.

Central Asia, and now widely spread in tropical Asia, Africa, and America.

Leucas lanata, *Benth.*, var.; *Fl. Brit. Ind.* iv. p. 681.—Shan hills at 4000 feet.

Western Himalayas to South India and South China.

The Shan plant is exactly like a specimen in the Kew Herbarium from Hainan.

Leucas diffusa, *Benth.*; *Fl. Brit. Ind.* iv. p. 689.—Shan hills at 4000 feet.

South India.

Microtæna cymosa, *Prain*; *Hook. Ic. Pl.* t. 1872; *Hemsl. in Journ. Linn. Soc.* xxvi. p. 306; syn. Plectranthus Patchouli, *Clarke, Fl. Brit. Ind.* iv. p. 624, et Gomphostemma insuave, *Hance in Journ. Bot.* 1884, p. 231.—Shan hills at 3000 feet.

Eastern India, cultivated; wild in Burma and Southern China.

Gomphostemma strobilinum, *Wall.*; *Fl. Brit. Ind.* iv. p. 696.—Shan hills at 2000 to 4000 feet.

Burma.

Gomphostemma Hemsleyanum, *Prain, MS.*, n. sp.

Affinis *G. parvifloro*, a quo differt petiolis brevioribus, foliis insigniter rotundato-crenatis, verticillastris densissimis, calycis lobis latis, nuculis nigris omnibus sæpius maturescentibus.

Meiktila.

We have this in fruit only, but it is easily distinguished from all the numerous specimens of *G. parviflorum*, Wall.

Leucosceptrum canum, *Smith*; *Fl. Brit. Ind.* iv. p. 699; syn. Teucrium macrostachyum, *Wall.*; *DC. Prodr.* xii. p. 574.—Shan hills plateau at 4000 feet.

North India, from Kumaon to Khasia.

Ajuga bracteosa, *Wall.*; *Fl. Brit. Ind.* iv. p. 702.—Shan hills at 5000 feet.

Afghanistan to China and Japan, and in Abyssinia.

Ajuga macrosperma, *Wall.*; *Fl. Brit. Ind.* iv. p. 704.—Shan hills at 3000 feet.

North India, from Kumaon to Khasia, Chittagong, and Pegu.

Plantagineæ.

Plantago major, *Linn.*; *Fl. Brit. Ind.* iv. p. 705.—Shan hills at 5000 feet.

Widely spread in Europe, Asia, and North Africa, and naturalized in almost all other countries where Europeans have settled.

Amarantaceæ.

Deeringia celosioides, *R. Br.*; *Fl. Brit. Ind.* iv. p. 714.—Meiktila.

Central and Eastern India, Malaya, China, and Australia.

Ærua scandens, *Wall.*; *Fl. Brit. Ind.* iv. p. 727.—Meiktila, and Shan hills terai at 3000 feet.

India, Malaya, China, Philippines, and tropical Africa.

Polygonaceæ.

Polygonum chinense, *Linn.*; *Fl. Brit. Ind.* v. p. 44.—Shan hills at 3000 feet.

Central, Southern, and Eastern India, Ceylon, Malaya, China, Japan, and the Philippines.

Polygonum orientale, *Linn.*; *Fl. Brit. Ind.* v. p. 30.—Shan hills at 4000 feet.

North India, Malaya, China, and Japan.

Polygonum glabrum, *Willd.*; *Fl. Brit. Ind.* v. p. 34.—Meiktila.

Tropical Asia, Africa, and America.

Polygonum sphærostachyum, *Meissn.*; *Fl. Brit. Ind.* v. p. 32. —Shan hills plateau at 5000 feet.

Temperate and subalpine Himalaya from Scinde to Sikkim, and in Western Tibet.

Fagopyrum cymosum, *Meissn.*; *Fl. Brit. Ind.* v. p. 55.—Shan hills at 3500 feet.

North India, from Kashmir to Sikkim, and in Western China.

Aristolochiaceæ.

Aristolochia Roxburghiana, *Klotzsch*; *Fl. Brit. Ind.* v. p. 75. —Meiktila.

Eastern and Southern India, Ceylon, and Malaya.

Piperaceæ.

Peperomia reflexa, *A. Dietrich*; *Fl. Brit. Ind.* v. p. 99.—Shan hills at 4000 feet.

Widely spread in tropical and subtropical Asia, Africa, America, and Australia.

Chloranthaceæ.

Chloranthus (§ Tricercandra) nervosus, *Coll. et Hemsl.*, n. sp.

C. Fortunei valde affinis, sed robustior foliis late obovatis utrinque acuminatis, venis primariis lateralibus utrinque 9–11 subtus elevatis prope marginem inter se anastomosantibus, andrœcii appendicibus brevioribus.

Shan hills at 4000 feet.

Apart from the much more numerous and more conspicuous primary veins and the shorter staminal prolongations, there is little to distinguish this from the Chinese *C. Fortunei*, Solms.

Laurineæ.

Cinnamomum vimineum, *Nees*; *Fl. Brit. Ind.* v. p. 131.—Shan hills at 3000 feet, *Manders*.

Penang.

This species was founded on very imperfect specimens, and the

Shan specimens, like those of Wallich, which we have seen, are flowerless; but Mr. C. Curtis has recently sent better specimens to Kew from Penang: pedicellis incrassatis clavatis, perianthio truncato, fructu ovoideo.

Lindera Laureola, *Coll. et Hemsl.*, n. sp.

Arbor præter pedicellos glaberrima, ramulis ultimis floriferis graciliusculis, cortice fere nigro, internodiis quam folia multoties brevioribus. *Folia* breviter petiolata, coriacea, late lanceolata, circiter tripollicaria, utrinque cuneata, vix acuta, integra, nitida, subtus pallidiora fere glauca, pennivenia, venis primariis utrinque 5–7 sat conspicuis. *Flores* umbellati (♂ tantum visi), circiter 6–8 aggregati, 3–4 lineas diametro; umbellæ in axillis foliorum sessiles, involucri bracteis orbicularibus cito deciduis; pedicelli 2–3 lineas longi, crassiusculi, sericeo-pubescentes; perianthii segmenta late obovata, rotundata, 3 exteriora extus puberula; stamina 9, 3 interiora glandulis 2 magnis sessilibus crassis sinuatis instructa.

Shan hills at 4000 feet.

Machilus Kingii, *Hook. f.* ?; *Fl. Brit. Ind.* v. p. 861.—Shan hills at 4000 feet.

Khasia.

The species of this genus are still very imperfectly defined.

Proteaceæ.

Helicia erratica, *Hook. f.*; *Fl. Brit. Ind.* v. p. 189.—Shan hills at 4000 feet, *Mander*, *Aplin*, and *Collett*.

Sikkim, Khasia, and Martaban.

The flowers of the Shan specimens are very densely racemose and nearly sessile.

Thymelæaceæ.

Wikstrœmia indica, *Endl.*; *Fl. Brit. Ind.* v. p. 195.—Shan hills at 3000 feet.

Chittagong, Tenasserim, Singapore, China, and the Philippines.

Linostoma scandens, *Kurz*, *Forest Fl. Burma*, ii. p. 334; *Fl. Brit. Ind.* v. p. 198.—Shan hills terai at 2000 feet.

Tenasserim to Singapore.

ELÆAGNACEÆ.

Elæagnus latifolia, *Linn.*; *Fl. Brit. Ind.* v. p. 202; syn. E. arborea, *Roxb.*; *Forest Fl. Burma*, ii. p. 331.—Shan hills at 5000 feet.

North and South India, Malaya, and China.

LORANTHACEÆ.

Loranthus pulverulentus, *Wall.*; *Fl. Brit. Ind.* v. p. 211; *Forest Fl. Burma*, ii. p. 318.—Fort Stedman and Meiktila, *Aplin* and *Collett*.

Subtropical North India from Garhwal eastward, Central India, the Concan and Pegu.

Loranthus pentandrus, *Linn.*; *Fl. Brit. Ind.* v. p. 216; *Forest Fl. Burma*, ii. p. 320.—Shan hills terai at 2000 feet.

Widely spread in Eastern India and Malaya.

Loranthus Scurrula, *Linn.*, var.; *Fl. Brit. Ind.* v. p. 208; *Forest Fl. Burma*, ii. p. 318.—Near Meiktila.

Throughout India and Malaya.

Loranthus (§ **Phœnicanthemum**) **Hemsleyanus**, *King*, n. sp.

"*Frutex* undique glaber, ramulis brunneis parce lenticellatis. *Folia* petiolata, coriacea, opposita vel subopposita, oblique lanceolata, 3–4 poll. longa, obtusa, basi cuneata, venis primariis circiter 6 costaque prominulis. *Spicæ* foliis dimidio breviores, axillares, sulcatæ. *Flores* in foveolis sessilibus, solitarii, 5–6-meri, 2–3 lineas longi; bractea annularis, quam calyx cyathiformis brevior; corolla aurantiaca, ante anthesin clavata, segmentis oblanceolatis demum arcte recurvis; filamenta crassa, quam perianthium breviora; antheræ ovatæ, crassæ; stylus gracilis, brevis, stigmate oblique truncato."—*King*, MS.

Shan hills at 5000 feet.

A species resembling *L. pulcher*, DC., but quite distinct.

Loranthus (§ **Elytranthe**) **Collettii**, *King*, n. sp.

"*Frutex* glaber, ramulis pallidis lævibus 4-angulatis (saltem in siccis) parce furfuraceis. *Folia* opposita, coriacea, ovato-

lanceolata, absque petiolo 5-6 poll. longa, obtusa, basi rotundata, leviter sinuata, costa subtus elevata, venis primariis utrinque 12–16; petiolus teres, circiter pollicaris. *Flores* speciosi, sanguinei, ad apices pedunculorum crassorum geminati, sessiles, 2½ poll. longi; pedicelli 4–5 lineas longi, ad nodos ramorum vetustorum fasciculati; bracteæ crassæ, coriaceæ, ovatæ, connatæ, involucrum naviculiformem inter flores septatum formantes, bracteolis breviores; bracteolæ 2, oblongæ, fere truncatæ, imbricatim obtegentes tubum formantes, calycem cyathiformem brevem longe excedentes, extus parce furfuraceæ; corolla tubulosa, curvata, sursum dilatata, lobis linearibus reflexis tubo duplo brevioribus, antheræ lineares, corollæ lobos fere æquantes; stylus filiformis, stamina æquans, stigmate ovoideo."—*King*, MS.

Shan hills plateau at 5000 feet.

"This magnificent species must, in my opinion, be placed in the section *Elytranthe*. Its inflorescence does not, however, quite conform to the technical characters given in Bentham and Hooker's 'Genera Plantarum,' inasmuch as the spikes are only two-flowered."—*King*, MS.

Viscum articulatum, *Burm.*; *Fl. Brit. Ind.* v. p. 226; *Forest Fl. Burma*, ii. p. 325.—Shan hills at 5000 feet.

Widely spread in India, Malaya, and Ceylon.

Viscum monoicum, *Roxb.*; *Fl. Brit. Ind.* v. p. 224: *Forest Fl. Burma*, ii. p. 324.—Shan hills at 5000 feet.

India and Malay peninsula.

Santalaceæ.

Osyris arborea, *Wall.*; *Fl. Brit. Ind.* v. p. 232.—Shan hills at 3000 to 4000 feet.

Eastern and Southern India and Ceylon.

Henslovia granulata, *Hook. f. et Thoms.*?; *Fl. Brit. Ind.* v. p. 232; *Forest Fl. Burma*, ii. p. 328.—Shan hills plateau at 5000 feet.

Eastern India and Burma.

The leaves of the Shan specimens are 11-nerved.

Scleropyrum Wallichianum, *Arnott*; *Fl. Brit. Ind.* v. p. 234;

syn. Sphærocarya Wallichiana, *Wight et Arnott.*—Shan hills at 4000 feet.

South India and Ceylon.

This genus was previously known from Malacca and Cochinchina, but not this species.

Phacellaria compressa, *Benth.*; *Fl. Brit. Ind.* v. p. 235.—Shan hills plateau at 5000 feet; parasitic on *Viscum monoicum,* Roxb.

Tenasserim.

Phacellaria caulescens, *Coll. et Hemsl.*, n. sp. (Plate XVII.)

Frutex parasiticus, aphyllus, caulescens, supra ramosus, pedalis, undique glaber, fere niger, ramulis teretibus ultimis floriferis graciliusculis. *Flores* minuti (♀ tantum visi), vix semilineam diametro, in foveolis ramulorum sessiles; perianthium subcarnosum, 5-merum, lobis deltoideis vix acutis valvatis. *Fructus* anguste ovoideus, subcarnosus, $2\frac{1}{2}$–3 lineas longus, semen unicum (imperfectum ?), examinatum album, 5-lobatum.

Shan hills at 4000 feet; parasitic on a *Loranthus.*

The size and habit characterize this species, which in these respects is nearest to the hoary *P. Wattii,* Hook. f.

DESCRIPTION OF PLATE XVII.

A plant of *Phacellaria caulescens,* Coll. et Hemsl., natural size.

Fig. 1, portion of a flower-bearing branch; 2, ♀ flower; 3, section of the same; 4, cross section of fruit; 5, vertical section of fruit; 6, seed. All enlarged.

EUPHORBIACEÆ.

Euphorbia prolifera, *Ham.*; *Fl. Brit. Ind.* v. p. 264.—Shan hills plateau at 5000 feet.

Kashmir and the Punjab eastward, and in Yunnan.

Bridelia montana, *Willd.*; *Fl. Brit. Ind.* v. p. 269.—Meiktila.

North India from the Punjab to Khasia, and also in Southern India.

Bridelia stipularis, *Blume*; *Fl. Brit. Ind.* v. p. 270; *Forest Fl. Burma,* ii. p. 369.—Shan hills at 4000 feet; also collected by Mr. Aplin.

Tropical India, Malaya, Ceylon, Philippines, and tropical Africa.

Sauropus concinnus, *Coll. et Hemsl.*, n. sp. (Plate XVIII.)

Frutex nanus (specimina nostra infra pedalia), erectus, undique glaber, stricte ramosus, caulibus ramulisque gracilibus angulatis, internodiis folia æquantibus vel brevioribus. *Folia* brevissime petiolata, crassa, erecta, ramulis appressa, orbiculari-cordata, maxima semipollicaria, subtus pallidiora, venis primariis lateralibus utrinque 3–4 conspicuis inter se anastomosantibus; stipulæ minutæ, acutæ, persistentes. *Flores* axillares, vix 2 lineas diametro, breviter pedicellati. *Flores* ♂ sæpius geminati; calyx subcarnosus, latus, 6-lobatus, appendicibus magnis truncatis; andrœcium latum, triangulare, depressum, triandrum, antheris sessilibus fere horizontalibus. *Flores* ♀ solitarii; calyx 6-partitus, segmentis distincte biseriatis fere orbicularibus undulatis inappendiculatis deorsum attenuatis; gynæcium latum, stylis brevibus bifidis, ramulis fere horizontalibus incurvis. *Fructus* ignotus.

Shan hills at 4000 feet.

DESCRIPTION OF PLATE XVIII.

A branch of *Sauropus concinnus*, Coll. et Hemsl., natural size.

Fig. 1, male flower in an early stage; 2, male flower fully developed; 3, female flower. All enlarged.

Phyllanthus Emblica, *Linn.*; *Fl. Brit. Ind.* v. p. 289.—Shan States, *Aplin.*

Throughout tropical India, Ceylon, and Malaya, and extending to South China.

Phyllanthus pomiferus, *Hook. f.*; *Fl. Brit. Ind.* v. p. 289; syn. Cicca macrocarpa, *Kurz*; *Forest Fl. Burma*, ii. p. 352.—Meiktila, and Shan hills at 5000 feet.

Pegu and Prome districts of Burma.

Phyllanthus (§ **Euphyllanthus**) **Prainianus**, *Coll. et Hemsl.*, n. sp.

Frutex ramis crassiusculis albidis glabris, ramulis lateralibus foliiferis floriferisque crebris brevibus gracilibus pubescentibus angulo acuto adscendentibus (deciduis ?), internodiis quam folia multo brevioribus. *Folia* disticha, ramulis appressa, brevissime petiolata, crassiuscula, oblongo-elliptica vel interdum fere orbicularia, usque ad semipollicaria, utrinque rotundata vel apice

breviter obtuseque acuminata, basi leviter cordata, integra, undulata, glabra, subtus pallidiora, venis primariis lateralibus utrinque circiter 7–8 distinctis. *Flores* glabri, axillares, dense fasciculati, circiter sesquilineam diametro, brevissime pedicellati, ♀ pauci cum ♂ intermixti, pedicellis gracilibus glabris. *Flores* ♂ numerosissimi; calycis segmenta æqualia, oblonga, obtusa: discus breviter 6-lobatus; stamina 3, in columnam graciliter stipitatam connata, antheris muticis arcte conniventis. *Flores* ♀ pauci, ♂ similes, disco majore cupulari 6-dentato; ovarium glabrum vel leviter pulverulentum, stylis crassis recurvis alte bifidis. *Fructus* non visus.

Shan hills at 5000 feet.

This resembles *P. Emblica*, Linn., but, apart from structural differences, it is easily recognized by its broader, much less numerous leaves.

Glochidion lanceolarium, *Dalz.*; *Fl. Brit. Ind.* v. p. 308; *Forest Fl. Burma*, ii. p. 343. (Var. ramulis foliisque secus costam pubescentibus.)—Shan hills at 4000 feet.

North-west India to Assam, Silhet, Chittagong, and Pegu.

Glochidion velutinum, *Wight*; *Fl. Brit. Ind.* v. p. 322.—Shan hills at 4000 to 5000 feet.

Eastern and Southern India and Burma.

Flueggia microcarpa, *Blume*; *Fl. Brit. Ind.* v. p. 328; syn. Cicca obovata, *Kurz, Forest Fl. Burma*, ii. p. 354.—Meiktila, and Shan hills, 3000 to 4000 feet.

Throughout India, Ceylon, Malaya, Southern China; and also in Australia and tropical Africa.

Breynia patens, *Benth. et Hook. f.*; *Fl. Brit. Ind.* v. p. 329; syn. Melanthesopsis patens, *Muell. Arg.*; *Forest Fl. Burma*, ii. p. 348.—Shan hills at 3000 to 4000 feet.

Throughout tropical India, Ceylon, Burma, and Tenasserim.

Aporosa villosa, *Baill.*; *Fl. Brit. Ind.* v. p. 345; *Forest Fl. Burma*, ii. p. 361.—Shan hills at 2500 feet.

Burma, Tenasserim, and Cochin China.

Antidesma cuspidatum, *Muell. Arg.*; *Fl. Brit. Ind.* v. p. 360.—Shan hills at 5000 feet.

Tenasserim, Malacca, and Singapore.

Antidesma diandrum, *Roth*; *Fl. Brit. Ind.* v. p. 361; *Forest Fl. Burma*, ii. p. 360.—Shan hills, 3000 to 4000 feet.

North and South India, Ceylon, Burma and Tenasserim.

Antidesma velutinum, *Tulasne*?; *Fl. Brit. Ind.* v. p. 361; *Forest Fl. Burma*, ii. p. 359.—Shan hills at 5000 feet.

Burma, Pegu, and Tenasserim.

Mallotus philippinensis, *Muell. Arg.*; *Fl. Brit. Ind.* v. p. 442; *Forest Fl. Burma*, ii. p. 381.—Shan States, *Aplin*.

India, Ceylon, Malaya, China, Philippine islands, and N. Australia.

Aleurites moluccana, *Willd.*; *Fl. Brit. Ind.* v. p. 384; *Forest Fl. Burma*, ii. p. 377.—Shan hills at 3000 feet; cultivated?

Malaya and Polynesia, and various parts of India as an escape from cultivation.

Croton oblongifolius, *Roxb.*; *Fl. Brit. Ind.* v. p. 386; *Forest Fl. Burma*, ii. p. 373.—Shan hills at 3000 to 4000 feet, *Aplin* and *Collett*.

North and South India and Ceylon.

Crozophora plicata, *A. Jussieu*; *Fl. Brit. Ind.* v. p. 409.—Meiktila; a common weed.

From Western Europe and North Africa to Ceylon and Burma.

Speranskia, sp. nov.?; fruticosa, flores ♂ tantum adsunt.—Shan hills at 4000 feet.

Speranskia is a genus of which only two species have hitherto been described; one from Northern and the other from Central China. Both are herbaceous, and the Shan plant is a small shrub; but in other respects they are very much alike, though in the absence of female flowers we do not venture to give our plant a name.

Cleidion javanicum, *Blume*; *Fl. Brit. Ind.* v. p. 444; *Forest Fl. Burma*, ii. p. 390.—Shan hills terai at 2000 feet.

Himalayas to Ceylon, Khasia, Burma, and Java.

Acalypha indica, *Linn. Sp. Pl.* ed. 1, p. 1003; *DC. Prodr.*

xv. 2, p. 868; *Hook. f. Fl. Brit. Ind.* v. p. 416; *Wight, Ic. Pl. Ind. Or.* t. 877.—Meiktila.

Tropical Asia and Africa.

Homonoia riparia, *Loureiro*; *Fl. Brit. Ind.* v. p. 455; *Forest Fl. Burma*, ii. p. 401.—Shan hills at 2000 feet.

India, Ceylon, and Malaya.

Baliospermum axillare, *Blume*; *Fl. Brit. Ind.* v. p. 461; syn. B. montanum, *Muell. Arg.*; *Forest Fl. Burma*, ii. p. 410.—Meiktila.

North and South India and Malaya, but not recorded from Ceylon.

Excœcaria, sp. nov.?; floribus ♂ perjuvenes tantum adsunt.—Shan hills at 5000 feet.

Urticaceæ.

Holoptelea integrifolia, *Planchon*; *Fl. Brit. Ind.* v. p. 481; syn. Ulmus integrifolia, *Roxb.*; *Forest Fl. Burma*, ii. p. 473.—Meiktila.

India, Ceylon, Malaya, and Cochinchina.

Celtis mollis, *Wall.*; *Forest Fl. Burma*, ii. p. 472; *Hook. f. Fl. Brit. Ind.* v. p. 482, sub C. tetrandra, *Roxb.*—Meiktila.

Burma.

Trema amboinensis, *Blume*; *Fl. Brit. Ind.* v. p. 484; syn. T. orientalis, var. amboinensis, *Kurz, Forest Fl. Burma*, ii. p. 468.—Shan hills at 4000 feet.

Sikkim eastward to Assam and Silhet and southward to Singapore and in the Andaman islands.

Morus indica, *Linn.*; *Fl. Brit. Ind.* v. p. 492; *Forest Fl. Burma*, ii. p. 468.—Shan hills at 4000 feet.

Kashmir to Assam, China and Japan.

Morus lævigata, *Wall.*; *Fl. Brit. Ind.* v. p. 492; *Forest Fl. Burma*, ii. p. 467.—Shan hills terai at 3000 feet.

North India from the Indus to Assam and Martaban and Tenasserim.

Ficus pyriformis, *Hook. et Arn.*, var. **ischnopoda**, *King, Ann. Bot. Gard. Calc.* i. p. 157, t. 201; *Fl. Brit. Ind.* v. p. 533;

syn. F. ischnopoda, *Miquel*; *Forest Fl. Burma*, ii. p. 456.—Shan hills at 4000 feet.

Eastern India, Malay peninsula, and China.

Ficus obtusifolia, *Roxb.*; *Fl. Brit. Ind.* v. p. 507; *Forest Fl. Burma*, ii. p. 443.—Shan States, *Aplin.*

Eastern India, Burma, and Malay peninsula.

Ficus Cunia, *Ham.*; *Fl. Brit. Ind.* v. p. 523; *Forest Fl. Burma*, ii. p. 461.—Shan States, *Aplin.*

North and Central India and Burma.

Cudrania javanensis, *Trecul*; *Fl. Brit. Ind.* v. p. 538; syn. C. amboinensis, *Kurz*, *Forest Fl. Burma*, ii. p. 434.—Shan hills at 4000 feet.

India, Ceylon, Malaya, Australia, and East Africa.

Bœhmeria platyphylla, *D. Don*; *Fl. Brit. Ind.* v. p. 578.—Shan hills at 3000 feet.

India, Ceylon, Malaya, China, Japan, and Africa.

Pouzolzia pentandra, *Benn.*; *Fl. Brit. Ind.* v. p. 583.—Shan hills at 3000 feet.

Afghanistan to Canara, Orissa, and Khasia.

Pouzolzia hirta, *Hassk.*; *Fl. Brit. Ind.* v. p. 586.—Shan hills at 4400 feet, *Manders.*

North India from Chamba eastward, Malaya, China, and Australia.

Pouzolzia viminea, *Wedd.*; *Fl. Brit. Ind.* v. p. 581; *Forest Fl. Burma*, ii. p. 425.—Shan hills at 4000 to 5000 feet.

India and Malaya.

Maoutia Puya, *Wedd.*; *Fl. Brit. Ind.* v. p. 592; *Forest Fl. Burma*, ii. p. 429.—Shan hills at 4400 feet.

North India and Burma.

JUGLANDEÆ.

Engelhardtia Colebrookiana, *Lindl.*; *Fl. Brit. Ind.* v. p. 596; syn. E. villosa, *Kurz*, *Forest Fl. Burma*, ii. p. 491.—Shan hills terai at 3000 feet.

North India, Burma, and China.

Engelhardtia spicata, *Blume*; *Fl. Brit. Ind.* v. p. 595; *Forest Fl. Burma*, ii. p. 491.—Shan States, *Aplin*.

North India from Nepal eastward, Burma, China, and Java.

CUPULIFERÆ.

Betula alnoides, *Ham.*; *Fl. Brit. Ind.* v. p. 599; syn. B. acuminata, *Wall.*; *Forest Fl. Burma*, ii. p. 476.—Shan hills plateau at 5000 feet.

North India from the Sutlej eastward to Mishmi, Khasia, and Muneypore, and southward to Martaban.

Quercus serrata, *Thunb.*; *Fl. Brit. Ind.* v. p. 601.—Shan hills plateau at 5000 feet.

Eastern India, China and Japan.

Quercus Griffithii, *Hook. f. et Thoms.*; *Fl. Brit. Ind.* v. p. 602.—Shan hills.

Sikkim and Khasia.

Quercus lanceæfolia, *Roxb.*; *Fl. Brit. Ind.* v. p. 616.—Shan hills at 5000 feet.

Sikkim to Khasia, Muneypore, and Burma.

Quercus Brandisiana, *Kurz*; *Fl. Brit. Ind.* v. p. 604; *Forest Fl. Burma*, ii. p. 488.—Shan hills at 3000 feet, *Aplin* and *Collett*.

Burma and Martaban.

Quercus Lindleyana, *Wall.*; *Fl. Brit. Ind.* v. p. 607; *Forest Fl. Burma*, ii. p. 486.—Shan hills at 3000 feet, *Aplin* and *Collett*.

Burma.

Mr. Aplin collected leaves of this with acorns of *Q. mespilifolia*, Wall., in consequence of which it was at first supposed that he had discovered a new species.

Quercus mespilifolia, *Wall.*; *Fl. Brit. Ind.* v. p. 605; *Forest Fl. Burma*, ii. p. 488.—Shan hills, *Aplin*.

Muneypore, Arracan, and Burma.

Quercus polystachya, *Wall.*; *Fl. Brit. Ind.* v. p. 610; *Forest*

Fl. Burma, ii. p. 485.—Shan hills at 4000 to 5000 feet, *Aplin* and *Collett*.

Muneypore and Moulmein.

Quercus glauca, *Thunb.*; *Fl. Brit. Ind.* v. p. 604; syn. Q. annulata, *Smith*.—Shan States, *Aplin*.

North India, from Kashmir to Khasia, and in China and Japan.

Quercus lineata, *Blume*; *Fl. Brit. Ind.* v. p. 605.—Shan States, *Aplin*.

North India, from Sikkim to Khasia, and in Java.

Castanopsis, an var. *C. tribuloidei*?; *Fl. Brit. Ind.* v. p. 622; syn. Castanea tribuloides, *Smith*; *Forest Fl. Burma*, ii. p. 480.—Shan hills at about 3000 feet, *Aplin*.

As limited in the 'Flora of British India,' *Castanopsis tribuloides*, A. DC., is an exceedingly variable species, and would probably include this, which is in quite young fruit.

Salicineæ.

Salix tetrasperma, *Roxb.*; *Fl. Brit. Ind.* v. p. 626; *Forest Fl. Burma*, ii. p. 493.—Shan hills at 4000 to 5000 feet.

Throughout India and Malaya (though apparently absent from Ceylon), and descending to the very tidal forests of Pegu, according to Kurz.

Coniferæ.

Pinus kasya, *Royle*; *Fl. Brit. Ind.* v. p. 652; *Forest Fl. Burma*, ii. p. 499.—Shan hills at 4000 feet, *Aplin* and *Collett*.

Khasia, Chittagong, and Burma.

Pinus Merkusii, *Junghuhn et De Vriese*; *Fl. Brit. Ind.* v. p. 652; *Forest Fl. Burma*, ii. p. 499.—Shan hills, *Aplin*.

Martaban, Tenasserim, Sumatra, and Borneo.

Cycadeæ.

Cycas pectinata, *Griff.*; *Forest Fl. Burma*, ii. p. 503.—Shan hills, common in the forests, *Aplin*.

Tenasserim and Martaban, and perhaps also Chittagong.

Hydrocharideæ.

Hydrocharis Morsus-ranæ, *Linn.*; *Fl. Brit. Ind.* v. p. 662.—Shan hills at 3000 feet.

Western Europe to China and Japan, and in Australia.

Boottia cordata, *Wall.*; *Fl. Brit. Ind.* v. p. 662.—Meiktila.

A plant previously unrepresented in the Kew Herbarium. Wallich collected it in the Irrawaddi near Ava, and in ponds on the summit of the Taongdong mountain. It is common in ponds and marshes frem Meiktila to Mandalay, growing gregariously, and flowering from October to January; its flowers covering the water with a sheet of white.

Orchideæ.

Dendrobium infundibulum, *Lindl.*; *Bot. Mag.* t. 5446; *Fl. Brit. Ind.* v. p. 721.—Shan hills terai at 3000 feet.

Moulmein.

Dendrobium lituiflorum, *Lindl.*; *Bot. Mag.* t. 6050; *Fl. Brit. Ind.* v. p. 740.—Shan hills at 4000 feet.

Assam, Burma, and Tenasserim.

Dendrobium fimbriatum, *Hook.*; *Bot. Mag.* t. 4160; *Fl. Brit. Ind.* v. p. 745.—Shan hills at 4000 feet.

Kumaon to Khasia and Muneypore.

Dendrobium capillipes, *Reichb. f. Xenia Orch.* ii. t. 169; *Fl. Brit. Ind.* v. p. 751.—Shan hills terai, 3000 feet.

Tenasserim.

Dendrobium heterocarpum, *Wall.*; *Bot. Mag.* t. 4708; *Fl. Brit. Ind.* v. p. 737; syn. D. aureum, *Lindl.*; *Bot. Reg.* 1839, t. 20.—Shan hills at 6000 feet.

India, Ceylon, Burma, Java, and the Philippine islands.

Bulbophyllum (§ **Racemosæ**) **comosum**, *Coll. et Hemsl.*, n. sp., *in Hook. f. Fl. Brit. Ind.* v. p. 762. (Plate XIX.)

Species insignis ex affinitate *B. hirti*, pseudobulbi etiamque folia desunt. *Scapus* stramineus, crassiusculus, rigidus, leviter curvatus, circiter pedalis, 2–3-vaginatus, in racemum basi geniculatum 2–3 poll. longum densissimum subnutantem terminans; vaginæ scariosæ, obliquæ, arcte amplectentes, 6–8 lineas longæ,

lamina brevi obtusa; pedicelli cum ovario 1–2 lineas longi, bracteis scariosis angustissimis acutis duplo longioribus suffulti. *Flores* pallidi, fere hyalini, angustissimi, circiter 9 lineas longi, eleganter fimbriato-hirsuti, pilis flaccidis paleaceis unicellularibus; sepala æqualia, e basi lato linearia vel fere filiformia, lateralia gibbosa; petala glabra, linearia, vix acuta, quam sepala multoties breviora; labellum parvum, basi sepalis adnatum, angustum, complicatum, geniculatum, extrorso-curvatum, simul versus columnam inflexum; columna brevis, breviter bidentata.

Shan hills at 6000 feet; common at Toongyi, but not seen elsewhere.

The curved stout scape of this species geniculate with the base of the dense bottlebrush-like raceme is quite unlike any other, and its affinity with *B. hirtum*, Lindl., is remote.

DESCRIPTION OF PLATE XIX.

An inflorescence of *Bulbophyllum comosum*, Coll. et Hemsl., natural size.

Fig. 1, a flower; 2, unicellular hair from the sepal; 3, a petal; 4, column and lip; 5, column. All enlarged.

Cirrhopetalum Collettii, *Hemsl.*, n. sp., *in Hook. f. Fl. Brit. Ind.* v. p. 773. (Plate XX., lapsu *Collettianum.*)

C. ornatissimæ proximum, sed sepalo postico petalisque appendicibus foliaceis (mobilibus?) insignibus conspicue differt. *Pseudobulbi* carnosi, tetragono-ovoidei, juveniles plurivaginati, vaginis subscariosis longitudinaliter circiter 9-nervis oblique truncatis apiculatis. *Folium* carnosum, enervium, anguste oblongo-lanceolatum, 2–3 poll. longum, obtusum, basi attenuatum, primum arcte complicatum. *Scapus* e vaginis oriundus, erectus, 3–6 poll. altus, crassiusculus, circiter 5–6-florus, bracteis membranaceis angustis acutissimis pedicellis brevioribus. *Flores* purpurei, 4–5 poll. longi, pedicellati, pedicellis 6–9 lineas longis; sepala lateralia basi gibbosa, angusta, longissime caudata, inappendiculata; sepalum posticum vix pollicare, basi gibbosum, 5-nervium, sursum margine appendicibus longis linearibus instructum; petala trinervia, e basi lata remote fimbriata, subite attenuata, margine appendicibus foliaceis cuneato-obovatis stipitatis dentatis ornata; labellum parvum, medio angustissime articulatum, mobile, supra medium incrassatum, linguæforme, recurvum; columna 2-alata, apice breviter bidentata.

Shan hills at 6000 feet.

The singular mobile appendages of the upper sepal and petals characterize this species, which is otherwise very near *C. ornatissimum*. It is in cultivation at Kew, but has not yet flowered there.

DESCRIPTION OF PLATE XX.

An inflorescence, pseudobulbs, and leaves of *Cirrhopetalum Collettii*, Hemsl., natural size; the first only from a dried specimen.

Fig. 1, a sepal; 2, a petal; 3, one of the petaline appendages; 4, column and labellum; 5, column; 6, pollinia. All enlarged.

Spathoglottis pubescens, *Lindl.*; *Wall. Pl. As. Rar.* t. 203; *Fl. Brit. Ind.* v. p. 814.—Shan hills at 4000 feet.

Eastern India and Burma, Martaban and Tenasserim.

A slender state with small flowers in which the central lobe of the labellum is trilobulate.

Arundina bambusifolia, *Lindl.*; *Gen. and Sp. Orch.* p. 125; *Warner, Orchid Album*, p. 139; *Fl. Brit. Ind.* v. p. 857.—Shan hills at 4400 feet, *Manders*.

Southern and Eastern India southward to Malacca.

Eulophia campestris, *Lindl.*; *Gen. and Sp. Orch.* p. 185; *Fl. Brit. Ind.* vi. ined.—Shan hills at 4000 feet.

Afghanistan eastward and in South India.

Eulophia (§ Cyrtopera) holochila, *Coll. et Hemsl.*, n. sp.

Pseudobulbi non visi. *Folia* floribus coetanea et bene evoluta non visa, anguste lanceolata, acuta, multinervia. *Scapus* robustus, simplex, erectus, sesquipedalis infra medium vaginis paucis latis instructus. *Flores* laxe racemosi, $1\frac{1}{2}$–2 poll. diametro, distincte pedicellati, pedicellis 6–9 lineas longis, bracteis membranaceis angustis acutissimis subæquantibus subtendis; sepala similia. oblonga, obtusa vel subacuta; petala sepalis similia; labellum integrum, orbiculari-oblongum, longiuscule calcaratum.

Shan hills at 4000 feet.

The entire rotundate lip is the most distinctive character of this species. Only very young leaves are known.

Cymbidium, sp. ?—Shan hills at 4000 feet.

The loose leaves accompanying flowers of a *Cymbidium* similar to *C. pubescens*, Lindl., are so unlike those of any *Cymbidium*

that we suspect they do not belong to the same plant. They are thick, short, and complicate, and were evidently distichously arranged.

Geodorum pallidum, *D. Don*; *Lindl. Gen. and Sp. Orch.* p. 176; syn. Geodorum candidum, *Wall.*; *Fl. Brit. Ind.* vi. ined.—Shan hills.

Eastern India, Burma, Malacca, and Ceylon.

Vanda cærulescens, *Griffith*; *Lindl. Fol. Orch.*, *Vanda*, p. 9; *Bot. Mag.* t. 5834; *Fl. Brit. Ind.* vi. ined.—Shan hills terai at 3000 feet.

Burma.

Spiranthes australis, *Lindl.*; *Gen. and Sp. Orch.* p. 464; *Wight, Ic. Pl. Ind. Or.* t. 1724; *Fl. Brit. Ind.* vi. ined.—Shan hills plateau at 5000 feet.

Afghanistan and India to Siberia, China, and Japan, and southward to Australia and New Zealand, and very closely allied to the European *S. æstivalis.* This is the most widely spread of any species of orchid; and the genus *Spiranthes*, section *Euspiranthes*, has a wider geographical area than any other generic type of this natural order.

Epipactis, sp. n.?, alabastris lanatis sepalis petalisque latis.—Shan hills at 3500 feet.

We have not succeeded in matching this in the Kew Herbarium, and the specimen is insufficient for description.

Habenaria geniculata, *D. Don*; *Lindl. Gen. and Sp. Orch.* p. 324; *Fl. Brit. Ind.* vi. ined.—Shan hills at 4400 to 6000 feet.

Khasia hills.

Habenaria rostrata, *Wall.*; *Lindl. Gen. and Sp. Orch.* p. 325; *Fl. Brit. Ind.* v. ined.—Shan hills at 4400 feet.

Khasia and Tenasserim.

Habenaria (§ **Veræ**) **Mandersii**, *Coll. et Hemsl.*, n. sp.

Tubera non visa. *Caulis* simplex, erectus, 9–12 poll. altus, graciliusculus, per totum foliaceus, glaber. *Folia* subcarnosa, ovato-lanceolata, 1–2 poll. longa, acuta, amplexicaulia, caulem

plus minusve appressa, glabra, venis inconspicuis. *Flores* 8–12 conferti, bracteis foliaceis paullo longiores, cum calcare circiter 15 lineas longi; sepala subcarnosa, lateralia leviter oblique ovata, obtusa, posticum galeatum; petala tenuiora, e basi latiora anguste oblonga, obtusa, sepala æquantia; labellum angustum, integrum, sepala æquans, pro fronte oris calcaris processu parvo linguæformi erecto instructum, calcare fere pollicari curvato basi incrassato; columna breviter apiculata; stigmata 2, valde elongata, claviformia, horizontalia, infra antherarum loculos arcte conniventia, minute papillosa, basi dente parvo erecto instructa; antherarum loculi in tubos angustos curvatos valde elongati; ovarium anguste 3-alatum.

Shan hills at 4400 feet, *H. Manders*.

This resembles *H. alata*, Hook., a West-Indian species which has two small lateral teeth to the labellum and a much shorter spur, and it seems to be quite alone among the Asiatic species with elongated stigmas and anther-cells in having a small entire labellum.

Habenaria (§ **Peristylus**) **monophylla**, *Coll. et Hemsl.*, n. sp.

Planta graciliuscula, circiter pedalis, per totum fere pubescens, unifoliata, infra folium paucivaginata, scapus infra flores 2–3-bracteatus. *Folium* crassiusculum, latum, scapum laxe involvens, marginibus late obtegentibus, obscure multinervium, vix acutum, utrinque pubescens, minute ciliolatum. *Flores* subsessiles, absque ovario 4–5 lineas longi, densiuscule racemosi, bracteis pubescentibus ciliolatis ovarium fere æquantibus; sepala et petala similia, glabra, ovato-oblonga, obtusa, circiter $1\frac{1}{2}$ lin. longa; labellum fere duplo longius, late trilobatum, deorsum valde attenuatum, supra puberulum, radiato-venosum, lobis subæqualibus erosis, calcare puberulo sepalis dimidio longiore crassiusculo recurvo basi conspicue incrassato; columna parva, antherarum loculis non elongatis, stigmatibus parvis; ovarium pubescens.

Shan hills at 4000 feet.

In floral structure this resembles several species, but the general hairiness of the plant, associated with the solitary leaf and small flowers with a broadly three-lobed lip, sufficiently characterize it. The Sikkim *H. unifolia* has an undivided lip.

Satyrium nepalense, *D. Don*; *Wight, Ic. Pl. Ind. Or.* t. 929; *Fl. Brit. Ind.* vi. ined.—Shan hills at 4000 feet.

Widely spread in India and extending to Ceylon.

Cypripedium concolor, *Bateman in Bot. Mag.* t. 5513, var. **Godefroyæ**, *Godefroy Lebœuf, Orchidophile*, t. 830 (species); *Bot. Mag.* t. 6876.—Meiktila, Prazer.

Including *C. niveum*, Reichb. f. (Bot. Mag. t. 5922) and *C. bellatulum*, Reichb. f. (Lindenia, t. 149), as proposed by Veitch (Manual of Orchidaceous Plants, iv. p. 19), this species is found in Burma, Siam, and Cambodia.

Scitamineæ.

Globba (§ **Ceratanthera**) **subscaposa**, *Coll. et Hemsl.*, n. sp.

Caules fasciculati, erecti, circiter pedales, pilosuli, vaginati, laminis 2–3 parvis tantum evolutis. *Folia* longe vaginata, supra vaginam sessilia, ovato-lanceolata, 6–18 lineas longa, acuta, utrinque primum plus minusve pilosula, supra glabrescentia, venis parallelis numerosis crebris. *Thyrsus* laxus, breviter pedunculatus, erectus, pauciflorus, ramulis pedicellisque gracilibus puberulis, bracteis parvis, bracteolis minutis. *Flores* flavi, parvi, absque stamino longiuscule exserto vix 9 lineas longi; calycis lobi obovato-spathulati, apice rotundati simul apiculati; corollæ tubus filiformis, puberulus, calycem duplo excedens; corollæ lobi lati, apice rotundati.

Shan hills at 4000 to 5000 feet; common throughout the Southern Shan hills above 4000 feet.

Easily distinguished from the few other known hardy species by its few small leaves.

Kæmpferia, sp.?, folia carent.—Shan hills at 3000 feet.

Though unable to match this and the next, in the absence of leaves, we have not ventured to describe them.

Curcuma, sp.—Shan hills plateau, here and there at 4000 feet.

Hedychium coronarium, *Linn.*; *Roxb. Fl. Ind.* i. p. 11; *Clarke's Reprint*, p. 4.—Shan hills at 4400 feet, *Manders*.

Widely spread in India, Ceylon, and Malaya.

Alpinia bracteata, *Roxb.*; *Fl. Ind.* i. p. 63; *Clarke's Reprint*, p. 21.—Shan hills at 4000 feet, *Manders*.

Sikkim, Assam, and Burma.

Canna indica, *Linn.*; *Roxb. Fl. Ind.* p. 1; *Clarke's Reprint*, p. 1.—Shan hills at 4000 feet, *Manders*.

Tropical Asia, Africa, and Polynesia, often colonized, as well as in America.

Hæmodoraceæ.

Ophiopogon, sp., specimen imperfectum folia carent.—Shan hills at 4000 feet.

Irideæ.

Iris nepalensis, *D. Don*; *Baker in Journ. Linn. Soc.* xvi. p. 143; *Sweet, Brit. Fl. Gard.* series 2, t. 11. Forma depauperata, 3–4 poll. alta.—Shan hills at 4000 feet.

North India from Garhwal to Assam.

There is little doubt that this is a starved-state of the species to which we have referred it. Like that, the leaves are thickly beset with very short purplish lines and dots.

Amaryllideæ.

Hypoxis aurea, *Lour.*; *Baker in Journ. Linn. Soc.* xvii. p. 108; syn. H. minor, *D. Don.*—Shan hills at 4000 to 4500 feet.

North India, Burma, Cochinchina, Java, China, Japan, and the Luchu Archipelago.

Crinum defixum, *Ker*; *Bot. Mag.* t. 2208; *Baker in Gard. Chron.* n. s. xv. p. 786.—Shan hills at 4000 feet.

Bengal and South India.

Crinum, n. sp.?, aff. *C. Cumingii*; flores imperfecti tantum adsunt.—Common in the dry forest about Pyambe in the plains of Upper Burma. A handsome and conspicuous plant with pink and white fragrant flowers, produced towards the close of the rainy season.

DIOSCOREÆ.

Dioscorea sativa, *Linn.*; *Benth. Fl. Austral.* vi. p. 461; syn. Helmia bulbifera, *Kunth, Enum. Pl.* v. p. 435; *Wight, Ic. Pl. Ind. Or.* t. 878.—Shan States at 4400 feet, *Manders.*

India, Malaya, and tropical Australia, often cultivated.

The species of this genus are much in need of revision.

Dioscorea dæmona, *Roxb.*?, *Fl. Ind.* iii. p. 805; *Clarke's Reprint*, p. 729; *Wight, Ic. Pl. Ind. Or.* t. 811.—Shan hills terai at 2000 feet; only very young inflorescence.

Widely spread in India and Malaya.

Dioscorea deltoidea, *Wall.*; *Kunth, Enum. Pl.* v. p. 340.—Shan hills at 4000 feet.

Afghanistan eastward to Burma and in South India.

Dioscorea spinosa, *Roxb.*; *Wall. Cat.* n. 5103.—Shan hills at 3000 to 4000 feet.

India and Malaya.

Dioscorea oppositifolia, *Linn.*; *Kunth, Enum. Pl.* v. p. 390; *Roxb. Fl. Ind.* iii. p. 804; *Clarke's Reprint*, p. 729.—Meiktila.

Widely spread in India and Malaya.

Dioscorea, species indescripta? *Folia* siccitate nigrescentia, simplicia, papyracea, late cordata, acuminata, 7–9-nervia, subtus parce hispidula. *Flores* ♂ tantum adsunt laxissime spicati, spicis gracillimis simplicibus folia excedentibus.

Shan hills at 4000 feet.

LILIACEÆ.

Smilax lanceæfolia, *Roxb.*; *Fl. Ind.* iii. p. 792; *Clarke's Reprint*, p. 725.—Shan hills at 4000 feet.

Sikkim to Khasia.

A second imperfect specimen with almost orbicular leaves may also belong to this species.

Asparagus asiaticus, *Linn.*?; *Baker in Journ. Linn. Soc.* xiv. p. 618.—Shan hills at 4000 feet.

South India, tropical and South Africa.

Polygonatum Kingianum, *Coll. et Hemsl.*, n. sp. (Plate XXI.)

Herba robusta, scandens, 4–5-pedalis, undique glabra. *Folia* pseudo-verticillata, 3–6 aggregata, crassa, subrigida, lineari-lanceolata, circiter 3-pollicaria, apice breviter cirrhifera, revoluta, subtus glauca, venis longitudinalibus crebris. *Flores* purpurei vel rosei, circiter 9 lineas longi, in axillis foliorum fasciculati, nutantes, pedicellis recurvatis quam flores paullo brevioribus; perianthium crassum, cylindricum, 5-costatum, lobis fere rectis obtusissimis; stamina inclusa, supra medium tubi affixa, filamentis (pars libera) brevissimis glabris, antheris magnis sagittatis; ovarium glabrum, stylo stamina æquante.

Shan hills at 4000 feet.

Characterized by short, thick leaves with prehensile tips and large flowers. *P. sibiricum*, Red., the only other species having prehensile leaves, is a much more slender plant with much smaller flowers.

Named after Dr. G. King, F.R.S., of the Botanic Garden, Calcutta, who has taken much interest in the present collection, and greatly assisted in the determination of the plants.

DESCRIPTION OF PLATE XXI.

Portion of a plant of *Polygonatum Kingianum*, Coll. et Hemsl., natural size.

Fig. 1, perianth, laid open ; 2, pistil : both enlarged.

Lilium nepalense, *D. Don* ; *Baker in Journ. Linn Soc.* xiv. p. 231 ; *Elwes, Monogr. Lilium*, t. 5, fig. A.—Koni, Shan hills, *Boxall* ; cult. Messrs. Low.

Western and Central Himalaya.

Lilium neilgherrense, *Wight, Ic. Pl. Ind. Or.* tt. 2031–32 ; *Baker in Journ. Linn. Soc.* xiv. p. 230 ; *Elwes, Monogr. Lilium*, t. 6.—Koni, Shan hills, *Boxall* ; cult. Messrs. Low.

Mountains of Southern India.

Lilium Bakerianum, *Coll. et Hemsl.*, n. sp. (Plate XXII.)

Caules (specimen unicum siccum tantum visum) crassiusculi, teretes, puberuli, 3–4 ped. alti, biflori. *Folia* alterna, crassiuscula, suberecta, fere linearia, bipollicaria, utrinque attenuata, subacuta, utrinque præcipue secus costam marginemque minute lepidota, venis obsoletis. *Flores* albi, erecti, longe pedunculati, campanulati, circiter 4 poll. longi et lati ; perianthii segmenta inæqualia, contigua, ut videtur leviter recurva, basi lata, maculata,

intus extusque nuda, exteriora anguste lanceolata, longe acuminata, interiora latiora, oblanceolata, apice rotundata simul abrupte minuteque acuminata, margine furfuraceo-pulverulenta; stamina quam perianthium fere dimidio breviora, stylo triente longiore.

Shan hills at 4000 feet.

We have much pleasure in naming this Lily after J. G. Baker, F.R.S., whose labours on the petaloid monocots have so greatly facilitated the work of those who have followed him. It is intermediate in character between *L. davuricum*, Gawl., and *L. japonicum*, Thunb., and is remarkable for the short genitalia.

DESCRIPTION OF PLATE XXII.

Lilium Bakerianum, Coll. et Hemsl., natural size.

Fig. 1, tip of perianth-segment, enlarged.

Disporum calcaratum, *D. Don*; *Baker in Journ. Linn. Soc.* xiv. p. 588.—Shan hills plateau at 4000 feet.

North India.

Disporum latipetalum, *Coll. et Hemsl.*, n. sp.

Species *D. calcarato* valde affinis, differt caule simplici (an semper?) foliis multinerviis, floribus majoribus perianthii segmentis obovato-spathulatis glabris, filamentis pulverulentis nec puberulis, stylo breviter trifido.

Shan hills at 3000 feet.

Paris polyphylla, *Smith*; *Kunth, Enum. Pl.* v. p. 118.—Shan hills at 4000 feet.

North India from Garhwal eastward into Central China.

PONTEDERIACEÆ.

Monochoria vaginalis, *Presl*, var.; *Solms in DC. Monogr. Phanerog.* iv. p. 524.—Shan hills terai at 2000 feet.

India, Ceylon, Malaya, China, and Mandshuria; also in tropical Africa.

COMMELINACEÆ.

(Named by C. B. Clarke, F.R.S.)

Commelina nudiflora, *Linn.*; *Clarke in DC. Monogr. Phanerog.* iii. p. 144.—Shan hills at 4000 feet, *Manders*.

Almost cosmopolitan in warm countries.

Aneilema scapiflorum, *Wight, Ic. Pl. Ind. Or.* t. 2073; *Clarke in DC. Monogr. Phanerog.* iii. p. 200.—Shan hills at 3000 feet.

North and South India and Tenasserim.

Aneilema giganteum, *R. Br.*; *Clarke in DC. Monogr. Phanerog.* iii. p. 212.—Shan hills at 4400 feet, *Manders.*

India, Malaya, tropical Australia, and Africa.

Cyanotis barbata, *D. Don*; *Clarke in DC. Monogr. Phanerog.* iii. p. 248.—Shan hills at 4000 feet, *Manders.*

North India and South China.

Alismaceæ.

Alisma Plantago, *Linn.*; *Micheli in DC. Monogr. Phanerog.* iii. p. 32.—Shan hills at 5000 feet.

All round the northern hemisphere and in Australia.

Naiadaceæ.

Potamogeton natans, *Linn.*, var.?; *Kunth, Enum. Plant.* iii. p. 127.—Shan hills plateau at 4000 feet.

P. natans is found all round the northern hemisphere and in Australia.

Eriocauleæ.

Eriocaulon quinquangulare, *Willd.*; syn. Leucocephala graminifolia, *Roxb. Fl. Ind.* iii. p. 612; *Clarke's Reprint*, p. 664.—Shan hills at 4000 feet.

India, Malaya, China, and Australia.

Cyperaceæ.

(Named by C. B. Clarke, F.R.S.)

Eleocharis afflata, *Steud. Cyper.* p. 76.—Shan hills terai at 2000 feet.

India, Malaya, China, and Japan.

Fimbristylis globulosa, *Kunth, Enum. Pl.* ii. p. 231.—Shan hills terai at 2000 feet.

India and China.

Fimbristylis Thomsoni, *Boeck.*; *Linnæa*, xxxvii. p. 37.—Shan hills at 4000 feet.

Eastern India and China.

Fimbristylis rigidula, *Nees*; *Wight, Contrib. Ind. Bot.* p. 99. —Shan hills at 5000 feet.

Eastern India and China.

Fimbristylis monostachya, *Hassk.*; *Steud. Cyper.* p. 107.— Meiktila.

Nearly all over the tropics.

Carex phacota, *Spreng.*, β. minor; *Wight, Contrib. Ind. Bot.* p. 126; *Boott, Carices*, i. p. 63, t. 168.—Shan hills at 5000 feet.

North and South India and Ceylon.

GRAMINEÆ: *Panicaceæ.*

Paspalum scrobiculatum, *Linn.*; *Roxb. Fl. Ind.* i. p. 278; *Clarke's Reprint*, p. 93.—Shan hills at 4000 feet, *Manders.*

Tropical and subtropical Asia, Africa, and Australia.

A glabrous and a very hairy variety were collected.

Paspalum brevifolium, *Fluegge*; *Benth. Fl. Austral.* vii. p. 461. —Shan hills at 4000 feet, *Manders.*

Tropical and subtropical Asia and Australia.

Paspalum concinnum, *Steud.*; syn. P. Royleanum, *Nees*; *Thwaites, Enum. Pl. Zeyl.* p. 358.—Meiktila and Shan hills at 4000 feet, *Manders.*

India and Ceylon, widely spread.

Eriochloa annulata, *Kunth*; *Benth. Fl. Austral.* vii. p. 463.— Meiktila.

Tropical and subtropical Asia, Africa, and Australia.

Panicum repens, *Linn.*; *Roxb. Fl. Ind.* i. p. 299; *Clarke's Reprint*, p. 101.—Meiktila.

Widely spread on the coasts of the Mediterranean, Asia, Australia, and eastern South America.

Panicum paludosum, *Roxb. Fl. Ind.* i. p. 307; *Clarke's Reprint*, p. 103.—Shan hills at 4000 feet, *Manders.*

Throughout India.

Panicum semialatum, *R. Br.*; *Benth. Fl. Austral.* vii. p. 472; *Thwaites, Enum. Pl. Zeyl.* p. 358.—Shan hills at 5000 feet.

Almost all over tropical Asia and Australia.

Panicum flavidum, *Retz.*; *Roxb. Fl. Ind.* i. p. 293; *Clarke's*

Reprint, p. 98; *Benth. Fl. Austral.* vii. p. 474.—Meiktila and Shan hills at 4000 feet, *Manders.*

Tropical and subtropical Asia and Australia.

Panicum cimicinum, *Retz.*; *Roxb. Fl. Ind.* i. p. 291; *Clarke's Reprint*, p. 98.—Meiktila.

India and Ceylon.

Panicum Colonum, *Linn.*; *Roxb. Fl. Ind.* i. p. 296; *Clarke's Reprint*, p. 98.—Meiktila.

Generally spread in the tropics of the Old World and also in America.

Panicum prostratum, *Lam.*; *Benth. Fl. Austral.* vii. p. 476; *Thwaites, Enum. Pl. Zeyl.* p. 358.—Meiktila.

Asia, Africa, Australia, and the West Indies.

Panicum psilopodium, *Trinius*; *Kunth, Enum. Pl.* i. p. 100; *Thwaites, Enum. Pl. Zeyl.* p. 360.—Meiktila.

India, Malaya, and Ceylon.

Panicum radicans, *Retz.*; *Kunth, Enum. Pl.* i. p. 126.—Shan hills at 4000 feet.

India, Malaya, and China.

Panicum plicatum, *Roxb. Fl. Ind.* i. p. 311; *Clarke's Reprint*, p. 104.—Shan hills at 4000 feet, *Manders.*

Tropical and subtropical Asia and Africa.

Panicum sanguinale, *Linn.*; *Roxb. Fl. Ind.* i. p. 315; *Clarke's Reprint*, p. 106 (sub *Milio*).—Shan hills at 4000 feet, *Manders.*

In nearly all warm countries.

Panicum ciliare, *Retz.*; *Roxb. Fl. Ind.* i. p. 290; *Clarke's Reprint*, p. 97.—Meiktila.

A variety of the preceding, and also widely spread.

Panicum Crus-galli, *Linn.*; *Benth. Fl. Austral.* vii. p. 479; *Thwaites, Enum. Pl. Zeyl.* p. 359.—Meiktila, and Shan hills at 4000 feet, several varieties, *Manders.*

Very widely diffused in tropical and subtropical regions, though often only as a colonist.

Setaria glauca, *Beauv.*; *Benth. Fl. Austral.* vii. p. 492; *Roxb.*

Fl. Ind. i. p. 284; *Clarke's Reprint.* p. 95 (sub *Panico*).—Meiktila and Shan hills at various elevations, *Manders*.

Almost universally spread in tropical and subtropical countries.

Setaria verticillata, *Beauv.*; *Benth. Fl. Austral.* vii. p. 494; *Roxb. Fl. Ind.* i. p. 301; *Clarke's Reprint*, p. 101 (sub *Panico*).—Meiktila and Shan hills at 4000 feet, *Manders*.

Widely spread; but, like the last, often existing only as a colonist.

Setaria italica, *Beauv.*; *Roxb. Fl. Ind.* i. p. 302; *Clarke's Reprint*, p. 108 (sub *Panico*).—Shan hills at 4000 feet, *Manders*.

Commonly cultivated, and now widely spread in a wild state.

Pennisetum japonicum, *Trinius*; *Kunth, Enum. Pl.* i. p. 159 (sub *Gymnothrice*).—Shan hills at 4000 feet, *Manders*.

China and Japan, but not previously found so far westward, we believe.

Coix gigantea, *Kœnig*; *Roxb. Fl. Ind.* iii. p. 570; *Clarke's Reprint*, p. 650.—Shan hills at 4000 feet.

Eastern and Southern India and the Malay peninsula.

Polytoca bracteata, *R. Br.*; *Benn. Pl. Jav. Rar.* p. 20, t. 5; syn. Coix heteroclita, *Roxb. Fl. Ind.* iii. p. 572; *Clarke's Reprint*, p. 650.—Shan hills at 4000 feet, *Manders*.

Eastern India and Malaya.

Polytoca Wallichiana, *Benth.*, *Journ. Linn. Soc.* xix. p. 52.—Shan hills terai at 2000 feet.

Burma and Tenasserim.

Chionachne Wightii, *Munro* ex *Benth. et Hook. f. Gen. Pl.* iii. p. 1113; syn. Tripsacum semiteres, *Wall.*—Shan hills at 3000 feet.

South India and Burma.

Arundinella Wallichii, *Nees*; *Steud. Gram.* p. 114.—Shan hills at 4000 feet, *Manders*.

Widely spread in India.

Arundinella setosa, *Trin.*; *Steud. Gram.* p. 114.—Shan hills at 4000 feet, *Manders*.

Widely spread in India.

Tragus racemosus, *Desf.*; syn. Lappago racemosa, *Willd.*, *Benth. Fl. Austral.* vii. p. 506, et L. biflora, *Roxb. Fl. Ind.* i. p. 281.—Meiktila.

Very widely diffused in tropical and temperate regions of both hemispheres.

Perotis latifolia, *Ait.*; *Roxb. Fl. Ind.* i. p. 233; *Clarke's Reprint*, p. 78.—Meiktila.

Asia, Africa, and Australia, if *P. rara*, R. Br., be the same.

***Imperata arundinacea**, *Cyr.*; *Benth. Fl. Austral.* vii. p. 536 syn. Saccharum cylindricum, *Linn.*; *Roxb. Fl. Ind.* i. p. 234 *Clarke's Reprint*, p. 78.—Meiktila.

Widely spread in the tropical and subtropical regions of the Old World; and also found in South America.

Saccharum spontaneum, *Linn.*; *Roxb. Fl. Ind.* i. p. 235; *Clarke's Reprint*, p. 79.—Meiktila.

Tropical and subtropical Africa, Asia, and Polynesia.

Saccharum Narenga, *Nees*, ex *Steud. Gram.* p. 411.—Shan hills at 3000 feet.

India and China.

Pollinia argentea, *Trinius*; *Hackel in DC. Monogr. Phanerog.* vi. p. 162; syn. Andropogon tristachyus, *Roxb. Fl. Ind.* i. p. 256; *Clarke's Reprint*, p. 86.—Shan hills at 4000 feet.

India, Malaya, Ceylon, and North-east Australia.

Pollinia grata, *Hackel in DC. Monogr. Phanerog.* vi. p. 175. —Popah district, Upper Burma.

India, Malaya, and China.

Pogonatherum saccharoideum, *Beauv.*; *Hackel in DC. Monogr. Phanerog.* vi. p. 192; syn. Andropogon monandrus, *Roxb. Fl. Ind.* i. p. 260; *Clarke's Reprint*, p. 87.—Shan hills plateau.

India, Ceylon, Malaya, China, Japan, and Polynesia.

Arthraxon ciliaris, *Beauv.*; *Hackel in DC. Monogr. Phanerog.* vi. p. 354.—Shan hills at 4000 feet.

Tropical and temperate regions in Asia, Africa, and Australia.

* The Andropogoneæ were determined by Mr. C. B. Clarke, F.R.S.

Rottboellia exaltata, *Linn. f.*; *Hackel in DC. Monogr. Phanerog.* vi. p. 293; *Roxb. Fl. Ind.* i. p. 354; *Clarke's Reprint*, p. 119.—Shan hills at 4000 feet.

Tropical Asia and Africa and in the West Indies.

Ophiurus perforatus, *Trinius*; *Hackel in DC. Monogr. Phanerog.* vi. p. 319; syn. Rottboellia perforata, *Roxb. Fl. Ind.* i. p. 356; *Clarke's Reprint*, p. 119.—Meiktila.

India, Ceylon, and Malaya.

Ophiurus corymbosus, *Gærtner*; *Hackel in DC. Monogr. Phanerog.* vi. p. 317; syn. Rottboellia corymbosa, *Linn.*; *Roxb. Fl. Ind.* i. p. 355; *Clarke's Reprint*, p. 119.—Shan hills at 4000 feet, *Manders.*

India, Malaya, and North-east Australia.

Ratzeburghia pulcherrima, *Kunth*; *Hackel in DC. Monogr. Phanerog.* vi. p. 321; syn. Rottboellia pulchella, *Wall.*, et Aikinia elegans, *Wall. Pl. As. Rar.* t. 273.—Meiktila.

Burma.

Much finer specimens than the original ones upon which the genus was founded.

Manisuris granularis, *Linn. f.*; *Hackel in DC. Monogr. Phanerog.* vi. p. 314; *Roxb. Fl. Ind.* i. p. 352; *Clarke's Reprint*, p. 118.—Shan hills at 4000 feet, *Manders.*

Tropical and subtropical regions of both hemispheres.

Ischæmum laxum, *R. Br.*; *Hackel in DC. Monogr. Phanerog.* vi. p. 243.—Meiktila.

Tropical Asia, Africa, and Australia.

Ischæmum angustifolium, *Hackel in DC. Monogr. Phanerog.* vi. p. 241; syn. Andropogon binatus, *Retz.*; *Roxb. Fl. Ind.* i. p. 255; *Clarke's Reprint*, p. 85.—Meiktila.

North-west India to China, Japan, and the Philippine islands.

Ischæmum rugosum, *Salisb.*; *Hackel in DC. Monogr. Phanerog.* vi. p. 206.—Shan hills at 4000 feet, *Manders.*

India, Malaya, and China.

Andropogon contortus, *Linn.*; *Hackel in DC. Monogr. Phanerog.* vi. p. 585; *Roxb. Fl. Ind.* i. p. 253; *Clarke's Reprint*, p. 85.—Shan hills at 4000 feet, *Manders.*

Tropical and subtropical regions throughout the world.

Andropogon gangeticus, *Hackel in DC. Monogr. Phanerog.* vi. p. 539.—Shan hills at 3000 feet.

North and Central India.

Andropogon foveolatus, *Del.*; *Hackel in DC. Monogr. Phanerog.* vi. p. 402; syn. Andropogon striatus, *Roxb. Fl. Ind.* i. p. 261; *Clarke's Reprint*, p. 87.—Meiktila.

Canary islands, tropical and subtropical Africa to the Mauritius and India.

Andropogon Trinii, *Steud.*; *Hackel in DC. Monogr. Phanerog.* vi. p. 558; syn. Chrysopogon serrulatus, *Trin.*—Meiktila.

Afghanistan to Ceylon and Burma, and in South Africa.

Andropogon Nardus, *Linn.*; *Hackel in DC. Monogr. Phanerog.* vi. p. 601; syn. A. Schœnanthus, *Roxb. Fl. Ind.* i. p. 274; *Clarke's Reprint*, p. 92.—Meiktila.

India, Ceylon, Malaya, China, New Caledonia, South Africa, South America, and the West Indies.

Andropogon montanus, *Roxb. Fl. Ind.* i. p. 267; *Clarke's Reprint*, p. 90; *Hackel in DC. Monogr. Phanerog.* vi. p. 90.—Popah hill at 5000 feet.

North-west India to South China.

Andropogon Sorghum, *Brot.*; *Hackel in DC. Monogr. Phanerog.* vi. p. 500; *Roxb. Fl. Ind.* i. p. 269; *Clarke's Reprint*, p. 90; syn. A. laxus, *Roxb. Fl. Ind.* i. p. 271; *Clarke's Reprint*, p. 91, teste *Hackel.*—Popah district.

Mediterranean region, India, Ceylon, China, Malaya, Africa, America, and Polynesia; often cultivated.

Andropogon pertusus, *Willd.*; *Hackel in DC. Monogr. Phanerog.* vi. p. 479; *Roxb. Fl. Ind.* i. p. 258; *Clarke's Reprint*, p. 87.—Meiktila.

Asia, Africa, and Australia.

Themeda Forskalii, *Hackel in DC. Monogr. Phanerog.* vi. p. 659; syn. Anthistiria ciliata, *Roxb.*, et A. polystachya, *Roxb. Fl. Ind.* pp. 247 et 248; *Clarke's Reprint*, p. 83.—Meiktila.

Asia, Africa, and Australia.

Themeda ciliata, *Hackel in DC. Monogr. Phanerog.* vi. p. 664; syn. Anthistiria scandens, *Roxb. Fl. Ind.* i. p. 248; *Clarke's Reprint*, p. 83.—Shan hills at 4000 feet.

North and South India and Mascarene islands. Also from South Africa, but perhaps originally introduced.

GRAMINEÆ: *Poaceæ.*

Aristida Cumingiana, *Trin. et Rupr.*; *Steud. Gram.* p. 140.—Shan hills at 4000 feet.

Eastern India, China, and Eastern Africa.

Aristida Hystrix, *Linn.*; *Roxb. Fl. Ind.* i. p. 350; *Clarke's Reprint*, p. 118.—Meiktila.

Widely spread in India, and also found in Mauritius.

Aristida Adscensionis, *Linn.*; *Kunth, Enum. Pl.* i. p. 190.—Meiktila.

Atlantic islands, Africa, Mascarene islands, Arabia, Persia, and India.

Sporobolus coromandelianus, *Kunth, Enum. Pl.* i. p. 213; syn. S. commutatus, *Kunth.*—Meiktila.

Widely spread in India.

A beautiful variety was collected having narrow, bright brown panicles of great symmetry.

Sporobolus indicus, *R. Br.*; *Kunth, Enum. Pl.* i. p. 212; *Benth. Fl. Austral.* vii. p. 622; syn. S. elongatus, *R. Br.*, et Vilfa elongata, *Trin.*—Shan hills at 4000 feet, *Manders.*

Tropical and subtropical Asia, Africa, Australia, and America.

Cynodon Dactylon, *Pers.*; *Kunth, Enum. Pl.* i. p. 259; syn. Panicum Dactylon, *Linn.*; *Roxb. Fl. Ind.* i. p. 289; *Clarke's Reprint*, p. 97.—Meiktila.

Now generally spread in warm countries, but often only as a colonist.

Enteropogon, sp., an *E. melicoidei*, var.? foliis pilis longis tenuissimis vestitis.—Meiktila.

The specimen is too young for satisfactory determination. *E. melicoides*, Nees, inhabits Ceylon and South India.

Chloris barbata, *Swartz*; *Roxb. Fl. Ind.* i. p. 329; *Clarke's Reprint*, p. 111.—Meiktila.

Very widely spread in tropical regions.

Chloris digitata, *Steud.*; syn. Melica digitata, *Roxb. Fl. Ind.* i. p. 326; *Clarke's Reprint*, p. 110.—Meiktila.

India, Ceylon, and Malaya.

Eleusine indica, *Gærtn.*; *Roxb. Fl. Ind.* i. p. 345; *Clarke's Reprint*, p. 116.—Meiktila, and Shan hills at 4000 feet, *Manders.*

Tropical and subtropical regions of both hemispheres.

Eleusine ægyptiaca, *Pers.*; *Roxb. Fl. Ind.* i. p. 344; *Clarke's Reprint*, p. 116.—Meiktila.

Throughout the tropics and extending into subtropical regions.

Pappophorum elegans, *Nees*; *Steud. Gram.* p. 199.—Meiktila.

South India and Burma.

Phragmites communis, *Trin.*; *Kunth, Enum. Pl.* i. p. 251.—Shan hills at 3000 feet.

Eragrostis Brownii, *Nees*; *Benth. Fl. Austral.* vii. p. 646.—Shan hills at 4400 feet, *Manders.*

India, Ceylon, Malaya, and Australia.

Eragrostis cylindrica, *Steud. Gram.* p. 267; syn. Poa cylindrica, *Roxb. Fl. Ind.* i. p. 333; *Clarke's Reprint*, p. 112.—Meiktila.

India.

Eragrostis unioloides, *Nees*; *Steud. Gram.* p. 264.—Shan hills at 4000 feet.

Widely spread in tropical Asia.

Eragrostis nigra, *Nees*; *Steud. Gram.* p. 267; *Benth. Fl. Austral.* vii. p. 643.—Shan hills at 4000 feet.

India, Malaya, and Australia.

Eragrostis pilosa, *Beauv.*; *Benth. Fl. Austral.* vii. p. 645.—Meiktila.

Very widely diffused in tropical and subtropical countries.

Eragrostis zeylanica, *Nees*; *Thwaites, Enum. Pl. Zeyl.* p. 373; *Steud. Gram.* p. 265.—Shan hills at 4000 feet, *Manders*.

India, Ceylon, Malaya, and China.

Eragrostis plumosa, *Retz.*; *Steud. Gram.* p. 265.—Shan hills at 4000 feet.

India, Malaya, China, and tropical Africa.

Eragrostis megastachya, *Link*; *Kunth, Enum. Pl.* i. p. 333; *Thwaites, Enum. Pl. Zeyl.* p. 373.—Meiktila and Shan hills at 4000 feet, *Manders*.

South of Europe, Africa, and Asia.

Eragrostis cynosuroides, *Retz.*; *Steud. Gram.* p. 264; syn. Poa cynosuroides, *Linn.*; *Roxb. Fl. Ind.* i. p. 333; *Clarke's Reprint*, p. 112.—Meiktila.

Widely spread in Asia and Africa.

Eragrostis bifaria, *Wight et Arnott*; *Thwaites, Enum. Pl. Zeyl.* p. 373; syn. Poa bifaria, *Vahl*; *Roxb. Fl. Ind.* i. p. 331; *Clarke's Reprint*, p. 111.—Meiktila.

Throughout India and Ceylon.

Eragrostis viscosa, *Trin.*; *Kunth, Enum. Pl.* i. p. 336; syn. Poa viscosa, *Retz.*; *Roxb. Fl. Ind.* i. p. 336; *Clarke's Reprint*, p. 113. Var. panicula ampla glumis longissime ciliatis simul dorso setosis.—Upper Burma.

The typical plant inhabits South India and Ceylon.

Dendrocalamus strictus, *Nees*; *Forest Fl. Burma*, ii. p. 558.—Shan States, *Aplin*.

Generally spread in India and Burma southward to Singapore and Java.

Filices.

(By J. G. Baker, F.R.S.)

Adiantum Capillus-Veneris, *Linn.*; *Hooker et Baker, Synop. Fil.* p. 123.—Shan hills at 3500 feet, *Manders.*

Europe, Asia, Africa, America, and Polynesia.

Polypodium (§ Niphobolus) fissum, *Baker*; *Hooker et Baker, Synop. Fil.* p. 351.—Shan hills at 3000 feet.

India, Malaya, China, and Africa.

Pteris aquilina, *Linn.*; *Hooker et Baker, Synop. Fil.* p. 162.—Shan hills, abundant on the grassy plateaux, *Aplin.*

Almost everywhere in temperate regions.

Equisetaceæ.

Equisetum debile, *Roxb.*; *Fl. Ind., Clarke's Reprint*, p. 745.—Shan hills at 4000 feet.

India, Malaya, China, Polynesia, Africa.

M. Smith del.t Ch. Fitch lith.

BOSCIA VARIABILIS, *Coll. et Hemsl.*

LINN. SOC. JOURN. BOT. VOL. XXVIII. PL. 2.

M. Smith delt.

Ch. Fitch lith.

CAPPARIS BURMANICA, *Coll. et Hemsl.*

M. Smith delt. Ch. Fitch lith.

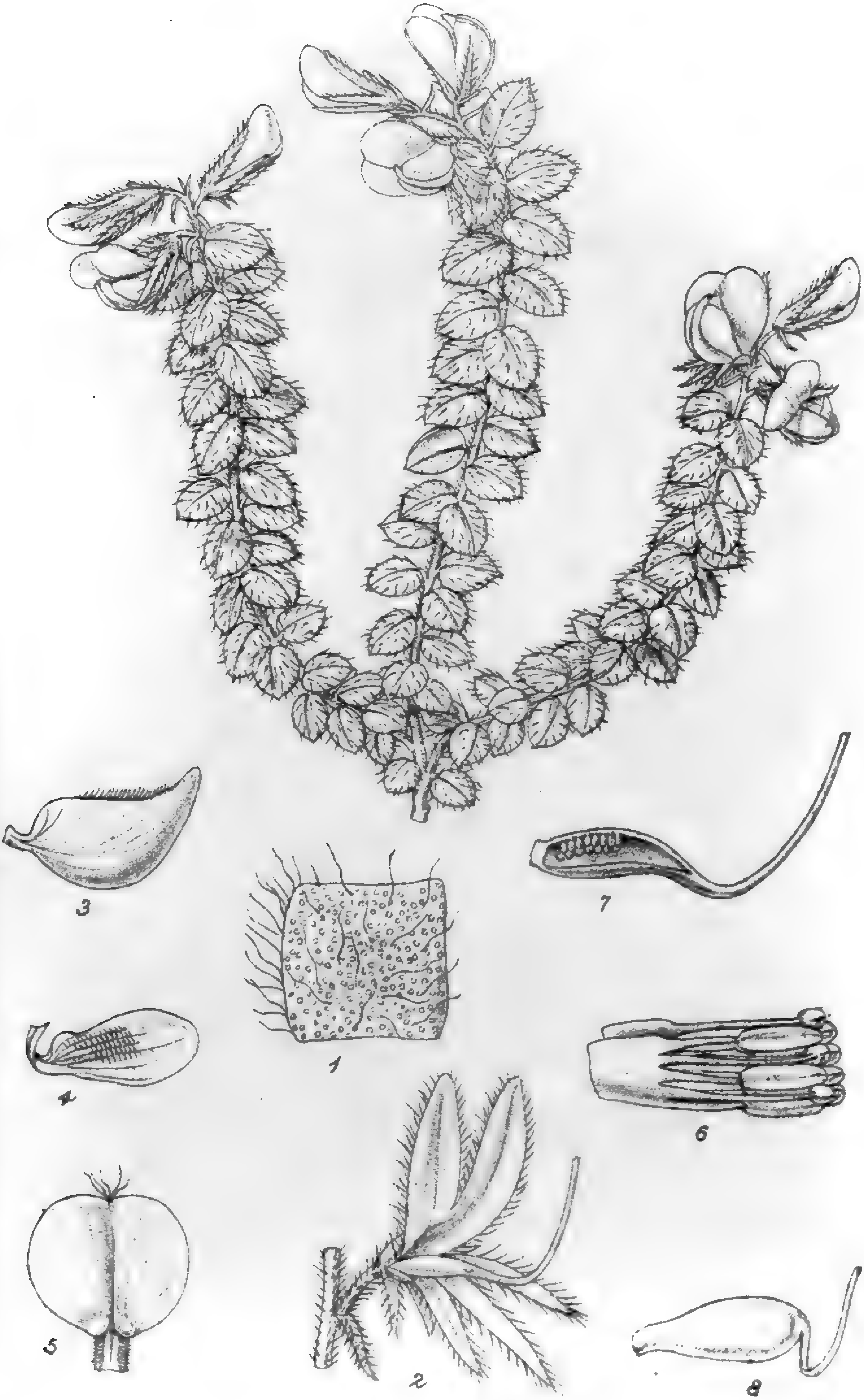
HYPERICUM PACHYPHYLLUM, *Coll. et Hemsl.*

Linn. Soc. Journ. Bot. Vol. XXVIII. Pl. 4.

M. Smith del.

Ch. Fitch lith.

IMPATIENS ECALCARATA, *Coll. et Hemsl.*



J.N.Fitch del.   Ch. Fitch lith.

CROTALARIA PERPUSILLA, Coll. et Hemsl.

M Smith delt.

Ch. Fitch lith

NEOCOLLETTIA GRACILIS, *Hemsl*.

M. Smith del.

Ch. Fitch lith.

PHYLACIUM MAJUS, *Coll. et Hemsl.*

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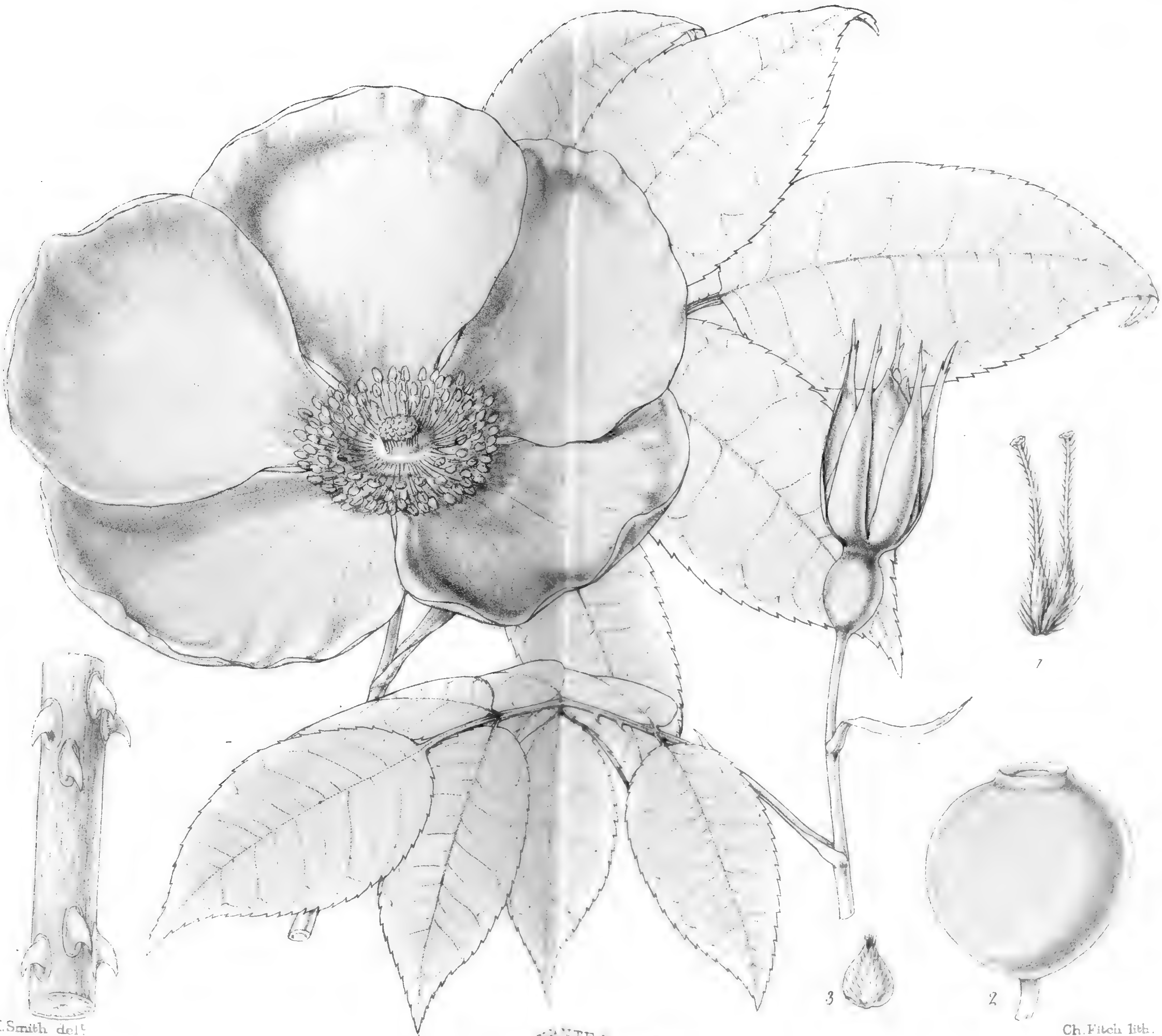
BAUHINIA TORTUOSA, *Coll. et Hemsl.*



M. Smith del^t

Ch. Fitch lith.

ROSA GIGANTEA, Collett.

M. Smith del.

Ch. Fitch lith.

ROSA COLLETTII, *Crépin*

 LINN. SOC. JOURN. BOT. VOL. XXVIII. PL. 11.

M. Smith delt. Ch. Fitch lith.

LONICERA HILDEBRANDIANA, *Coll. et Hemsl.*

M. Smith del. Ch. Fitch lith.

INULA CRASSIFOLIA, *Coll. et Hemsl.*

LINN. SOC. JOURN. BOT. VOL. XXVIII. PL. 13.

M Smith del.

Ch Fitch lith.

CEROPEGIA NANA, *Coll. et Hemsl.*

M. Smith del.

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BRACHYSTELMA EDULIS, *Coll. et Hemsl.*

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BLINKWORTHIA LYCIOIDES, *Chorsa*.

M. Smith del.

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STROBILANTHES CONNATUS, *Coll. et Hemsl.*

M. Smith del.

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PHACELLARIA CAULESCENS, *Coll. et Hemsl.*

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CIRRHOPETALUM COLLETTIANUM, Hemsl.

LINN. SOC. JOURN. BOT. VOL. XXVIII. PL. 21.

M. Smith del.

Ch. Fitch lith.

POLYGONATUM KINGIANUM. Coll. et Hemsl.

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Ch. Fitch lith.

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The GENERAL INDEX to the first twenty volumes of the Journal (BOTANY) and the Botanical portions of the Proceedings from November 1838 to June 1886 is now ready for delivery to the Fellows on Application.

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NOTICE.

Vols. XXVI., XXVII., and XXVIII. are in course of simultaneous issue, to expedite the publication of papers, and the Parts already published are as follows :—

Vol. XXVI. Nos. 173–175.

(Nos. 176–180 inclusive are reserved for the completion of Messrs. Forbes and Hemsley's "Index Floræ Sinensis.")

Vol. XXVII. Nos. 181–184.

(Nos. 185–188 will complete this Volume. No. 185-186 is in the press and will be issued in a few days.)

Vol. XXVIII. Nos. 189–191, the present Part.

Attention to this announcement is specially requested, to prevent application to the Librarian for unpublished Parts.

The Meetings of the Society during the first part of the ensuing Session will be as under :—

November.	Thursday, the	6th.
"	"	20th.
December.	"	4th.
"	"	18th.

The Chair will be taken at 8 P.M. precisely.

DECEMBER 15. *Price 6s.*

THE JOURNAL

OF

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VOL. XXVIII. **BOTANY.** No. 192.

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NOTE.—The Charter and Bye-Laws of the Society, as amended to the 21st April, 1881, have been reprinted, and may be had on application.

On the Vascular Systems of Floral Organs, and their Importance in the Interpretation of the Morphology of Flowers. By Rev. Prof. G. Henslow, M.A., F.L.S., &c.

[Read 7th March, 1889.]

(Plates XXIII.-XXXII.)

Introduction.

The study of the morphology of flowers is tolerably comp lete as it forms the basis of Systematic Botany. To understand their structure, however, when it is obscure in the fully developed state, as is not infrequently the case, the development of the floral organs must be traced. Payer's 'Organogénie Végétale comparée,' without being an absolutely exhaustive treatise, nevertheless goes far towards supplying very nearly all that is needed in this direction. The third and final investigation, however, seems yet to be done—namely, a research into the origin and distribution of the vascular cords within the floral axis, with the view of discovering how the various members of the floral whorls are supplied with them.

The importance of this line of research lies in the fact that the origin, position, and union, when it occurs, of every organ are bound to the particular cord or "trace" in the axis which subsequently enters it. No visibly appreciable differences are to be detected between the traces of a sepal, a petal, a stamen, or a carpel. They may, or may not, vary somewhat in size, but nothing of the nature of differential characters can be relied upon. They all consist of the same two elements—spiral vessels or tracheæ, representing xylem, and sieve-tubes or soft bast, constituting the phloëm. A difference in the amount of these two elements, and especially in their arrangement in the cord, supplies some features of importance—more particularly one which Ph. van Tieghem recognized but applied somewhat too rigorously, as it seems to me. In his investigations upon the anatomy of the pistil*, which were specially directed to ascertain how far the axis entered into the structure of that organ, he regarded a circle of

* 'Recherches sur la Structure du Pistil,' 1868. To the later edition of which he added 'L'Anatomie Comparée de la Fleur,' 1871. See also "Structure et Développement du Fruit," par M. C. Cave, Ann. des Sci. Nat. 5e sér. x. p. 123.

vascular cords which have their tracheæ on the inner side, *i. e.* facing the medulla, and the phloëm on the outside of it, *i. e.* facing the cortex, as indicating an axis; but when the circle is broken up and these two elements of the cords are altered or reversed in position, as they often are in the placentas of a carpel, he then pronounced them to be "foliar." This latter condition, I think, is undoubtedly true; but he does not, however, appear to have noticed that they are very far from being absolute distinctions. Thus, in his figure of the anatomy of *Campanula medium* (*op. cit.* pl. 12. figs. 69, 70) there is an apparently truly axial cylinder; but the bases of the ovary-cells are present; and in fig. 72 the cords facing the septa constitute an "axial" ring, while those facing the placenta have the tracheæ reversed. Again, in his figure of Balsam (pl. 10. fig. 34) there are five cords oriented and symmetrically arranged in a circle as if axial, *but the dorsal cords of the carpels are already differentiated.* Now this latter condition of things is not at all infrequent. If the reader will turn to my figures as follows:—*Reseda* (IX. 5; Pl. XXIV.), *Dianthus* (X. 8; Pl. XXIV.), *Silene* (XI. 7; Pl. XXV.), *Sedum* (XXVII. 4; Pl. XXVIII.), *Azalea* (XLI. 6; Pl. XXIX.), *Digitalis* (XLII. 7; Pl. XXX.), it will be seen that the cords are still arranged more or less accurately as if axial; but they are nevertheless carpellary, as the distinction between the dorsal and placentary cords is already pronounced *.

With reference to the relative positions of the tracheæ and phloëm, it is an extremely common occurrence for the medullary and other cords to have the tracheæ either accurately localized in the centre of a cylinder of phloëm, as in *Primula*, or else scattered irregularly through it. I have no hesitation in saying that these latter arrangements are the predominating ones in all floral structures. Moreover, the methods of change of position of the tracheæ of a cord from an internal to a central or external position are not always the same, as I shall explain later on.

Of this kind of research I am only acquainted with M. Ph. van Tieghem's work as being anything approaching a general consideration of the subject, with the sole exception of the order *Orchideæ*; for this has been somewhat specially treated

* For a further discussion on the orientation of cords &c., I would refer the reader to my work, 'The Origin of Floral Structures' (INT. SCI. SER., LXIV.), p. 71 &c.

by several observers *. Moreover, with regard to Van Tieghem's work, it is more especially the pistil to which he paid attention, at least in his first paper; though he subsequently treated of the anatomical details of the other organs of several flowers.

The present contribution does not pretend to be exhaustive, but is an endeavour to open up a comparatively new field of observation; for I am convinced that it will enable us to advance some way nearer to the solution of several morphological problems, if it do not actually solve the difficulties which have beset the investigations of floral structures.

Peduncles and Pedicels.

Before treating of flowers, some remarks may be made on the axes of inflorescences. The anatomical details observable in them contain several points of interest. Thus, while one is accustomed to recognize a single and symmetrical circle of cords round a central medulla as characteristic of exogens, and an irregular distribution as the peculiar feature of endogens, pedicels reveal the fact that these arrangements can be reversed, and that the exogenous type is frequently to be found in endogens and *vice versâ*. Thus, many pedicels of Endogens with six leaves to their perianths have six cords as symmetrical in position as those of Exogens. On the other hand, some exogenous plants may closely resemble certain endogenous ones in the arrangement of their cords. Thus, *Anemone* (II. 1; Pl. XXIII.) has a double circle of cords surrounding a lacuna in the medulla exactly like the peduncle of a Daffodil; while the pedicel of the Apple (XXIV. 1; Pl. XXVII.) closely resembles an ordinary endogenous stem.

Another point of resemblance lies in the supportive tissues, namely, in the prevalence of pericycular sclerenchyma forming a cylinder outside the cords. The endoderm is not often distinguishable, though its position may be occasionally presumed from the localization of starch, and is recognizable in some orders, as the *Caryophylleæ*, and in *Lonicera* &c. If a flower be pendulous, it is usually because the pedicel is more or less deficient in this supportive tissue where the flower-stalk bends. The stiff wiry

* See "On the Floral Conformation of the Genus *Cypripedium*," by Dr. M. T. Masters, Journ. Linn. Soc. vol. xxii. p. 402; also Prof. E. Pfitzer's 'Morphologische Studien üb. d. Orchideenblüthe,' Heidelberg, 1886.

character of many, otherwise slender stalks, as of *Ixia*, Pinks, &c., is attributable to the presence of this structure. In some cases collenchyma answers the purpose, as in *Cyclamen*; and the curious way in which the peduncles of this flower collapse when fertilization has not been effected is a consequence of the withholding of fluid; whereas in *Ixia*, if the flower be dead, the sclerenchymatous cylinder of the peduncle is sufficient to enable it to remain nearly as rigid as before.

Another distinctive feature between the two classes resides in the way the pedicels are formed in an umbel from a common peduncle. This is well seen by comparing *Ribes* (XXV. 1–3; Pl. XXVIII.) or *Primula* (XLIX. 1–5; Pl. XXXI.) with *Narcissus Tazetta* (LVII. 1–7; Pl. XXXII.). In the former, a portion of the fibro-vascular cylinder of the peduncle bulges out like a loop or horseshoe, as seen in a transverse section. The outermost cord or cords separate off and supply the bract, leaving two crescent-like portions, their concavities facing each other. These close up and form a small cylinder for the future pedicel which will issue from the axil of the bract. In some cases, if the peduncle contain a few isolated cords, and not a completely connected cylinder, the tracheæ of each of the isolated cords multiply by chorisis, spread out like a fan, until, by repeated division, the outer ones meet, and then collectively form a cylinder of themselves. This now supplies the pedicel. Other cords pass out and supply the bracts. Such a method obtains in *Erodium cicutarium* (XVI. 1–3; Pl. XXVI.); and finds a parallel, in the way the stamens are supplied with a central cord, in *Euphorbia* (LII. 4–5; Pl. XXXI.).

In Endogens the peduncle, *e.g.* of *Narcissus Tazetta* (LVII. 1–7; Pl. XXXII.), contains a circle of large cords embedded in loose parenchyma which has generally a lacuna in the centre. There is usually a circumferential series of smaller cords irregularly disposed. On reaching the solid node, the cords all follow oblique directions, and branch in an extraordinarily confused manner. They then gradually rearrange themselves into groups of variable numbers, such as five or six, or even so few as three if the pedicels are of small diameter. The fundamental tissue being at first uniform throughout, gradually becomes marked out into islets, which separate themselves by developing epidermides. Thence, the petioles, often angular in section from their origin, are perfectly formed.

Passage from Pedicels to the Floral Receptacle.

Some peduncles and pedicels have just as many cords as there are leaves to the perianth for considerable distances downwards. It is, however, more often the case that the number does not accurately coincide with them, there being one or two more or less than the right number. These differences are immaterial; for if there be too few, one or two will divide, and so complete the required number as they approach the calyx; or, as is more generally the case, they all begin to increase by repeated radial chorisis till a complete cylinder is formed, if it have not already existed throughout the peduncle or pedicel.

Then, if the sepals have not a particularly broad base for their insertion, one cord is given off to each sepal, and, having entered it, divides into three or more, and may ramify in various degrees. In other cases, as the Buttercup, Foxglove, &c., about five or six cords are given off to each sepal; so that the ring (as seen in a transverse section) is not divided so observably into definite and prominent groups of cords. The broken ring now tends to or quite closes up, and prepares for a new whorl. Here, however, differences occur. In *Ranunculus* and its allies (Pl. XXIII.) repeated lateral, *i. e.* radial, chorisis takes place, and small isolated cords are sent off to the stamens and carpels. In other cases, where the stamens are epipetalous, the sepaline and petaline cords divide by tangential chorisis *; or it may be very irregularly, and so supply cords for the stamens which thence stand superposed to them, as in *Lychnis*.

In this way, for example, do the original cords of the five primary "emergences" which develop into the andrœcium of the Hollyhock branch by radial and tangential chorisis, and so give rise to a multifold cluster of filaments and anthers in a normal flower (cf. *Malva*, XIII.; Pl. XXV.).

In ordinary flowers each whorl has its own proper function: but since their cords are all fundamentally alike when axial, it is

* I use the words "radial" and "tangential" as applied to chorisis in senses opposite to those of Ph. van Tieghem, respectively; for he applies the words as indicating the *results*, not the *processes*. Thus, if two organs are superposed and originate by chorisis from a common cord, he would call the chorisis *radial*, because the resulting organs stand on the same radius. I call such chorisis *tangential*; for it conveys the idea of a section of the cord made parallel to the tangent.

not surprising, but altogether in accordance with the principles of Evolution, that the organs which receive them should be able to interchange their functions. This possibility becomes very apparent in all kinds of monstrous flowers, so that nearly every organ, from bract to carpel, has been known to attempt to assume the character of every other. When, however, we search for the immediate causes, we are almost entirely baffled; for we are now dealing with the subtle properties of life, which are at present both unknown and apparently unknowable.

It is not, however, necessary to appeal to teratology; for in every normal flower the extremely close connection between two or more organs of different kinds may be seen in the fact that it is of the commonest occurrence for a cord to branch, and each branch to enter a different organ respectively. Thus, the cord of the petal of *Primula* divides tangentially, and one branch enters the filament, the other into the petal-lobe. Two particular cords of the circle in *Pelargonium zonale* divide radially, and while one supplies a petal, the other forms a lateral vein in a sepal (XVII. 3-5; Pl. XXVI.). Again, a sepaline cord of *Campanula medium* supplies a dorsal carpellary, a staminal, and a petaline cord as well.

Reunion of Cords.

This is a phenomenon which may be regarded as the converse of chorisis. The process is effected in several ways:—Thus (1) a broken vascular cylinder may become entire by increasing the number of the cords by radial chorisis till they all meet; so that from there having been a few, say four or five only, they will form a completely connected cylinder. This is of frequent occurrence in pedicels in order to prepare for the floral members. Again, when a circle has thus become broken by furnishing any one of the whorls with its particular and definite number of cords, the remaining ones may close up again by radial chorisis for another whorl, and so on.

(2) Besides the closing up of entire circles, retaining, however, a medulla within them, forming a vascular cylinder, individual cords may divide into two or more parts, and the adjacent members of two distinct groups may coalesce. This is seen in *Pelargonium*, as will be described in detail hereafter.

(3) An axial circle may contract until the medulla vanishes;

and it becomes a single cord of tracheæ when the ovules are reached.

(4) An isolated cord of a peduncle with its wedge-like mass of tracheæ may increase in size like a fan, the outer portions continually branching till they meet at the other end of a diameter, and so form a complete cylinder, which then constitutes the vascular cord of a pedicel. This occurs in *Erodium cicutarium* (XVI. 1–3; Pl. XXVI.) in forming the three pedicels of the umbel of that flower.

(5) Another form of union occurs when two adjacent members, say the cords of two sepals, throw off right and left portions which meet; they then may coalesce and run up the middle of the next membrane lying between them, of the following walls. This is what takes place in *Campanula Medium*, in order to supply the corolla with its five midribs, as illustrated by Ph. van Teighem. (See also *Calendula*, XXXVI. 10, 11; and *Jasione*, XXXIX. 4; Pl. XXIX.)

(6) Another illustration is seen in the *Umbelliferæ* (XXIX. Pl. XXVIII.). The two carpels stand face to face with the margins in contact. The cords proper to the margins or placentas ought to be four in number; but as only one ovule is developed in each ovary-cell, they are reduced to two. These, which are slightly divergent at the base, soon coalesce, and form the one cord which runs up the middle of the common tissue between the ovary-cells. The cord becomes isolated in the ripe state of the fruit, and constitutes the so-called stylopod, which is therefore not axial, but carpellary.

(7) Though marginal cords of carpels are usually quite distinct from the dorsal, except by being connected by lateral branches which anastomose with it, in *Ranunculus Flammula* (III. 3; Pl. XXIII.) the two marginals run to the top of the ovary, then curling over it, pass down the opposite side, and finally join the dorsal cord.

Other instances might be given; but the preceding illustrations will be sufficient to show how frequent and various are the methods of union and reunion between the cords.

Rearrangement of the Elements of the Cords.

I have already said that as long as cords are axial in a peduncle or pedicel, the tracheæ are situated on the inner angle, and the

phloëm on the outer part of the wedge-shaped cord, as seen in a transverse section. There may be an indentation on the phloëm, thus giving a cordate appearance. This indicates a preparation for chorisis. When the cords pass into the floral receptacle, the tracheæ begin to lose their precise arrangement, first, by spreading laterally and by multiplying the tracheæ by radial chorisis. The latter then often become central within a circular phloëm; or, if this be oval or irregular in outline, the tracheæ are dispersed throughout it.

Thus when they form the ribs and veins of petals, the cords are mostly cylindrical *, with the tracheæ central. When, however, they are destined to supply the margins of the carpels and thence to send off branchlets to the ovules, a section shows great irregularities; while the tracheæ may pass from one, the inner, side of the phloëm to the outer, *i. e.* facing the ovary-cell. The appearance of a circular ring of cords being axial is of course heightened when there is a central medulla within the circle of cords. As soon, however, as the medulla vanishes by the gradual constriction of the vascular cylinder, then M. van Tieghem considers the axis to be extinct. This, as a rule, takes place at least as soon as the level of the lowest ovules is reached.

Now, every carpel is theoretically, and indeed normally, provided with three cords, one dorsal and two marginals or placentary. If the pistil have an axile placentation, then all the pairs of marginal cords may be grouped round a central medulla as if axial, and the tracheæ may or may not be oriented inwards †. The three cords have branched from a common stem below; and I would regard the point where they have thus separated as the termination of their axial existence, and at least would call them *potentially* foliar, although the tracheæ may still remain facing the centre.

In Hellebore and *Eranthis* (IV. 4; Pl. XXIII.) the carpels are, so to say, already sketched out in the receptacle before they become actually free from each other; and although the marginal cords have their tracheæ oriented inwards, the three

* Some of them in the corolla-tube of Honeysuckle (XXXII. 6; Pl. XXVIII.) are decidedly wedge-shaped. *Sedum Telephium* (XXVII. 4; Pl. XXVIII.) forms a complete cylinder within the ovary-cells; but it really represents placental cords, as the dorsal cords are present.

† They are so in *Sedum* (XXVII. 4–6; Pl. XXVIII.); but the tracheæ are central in *Primula* (XLIX. 8; Pl. XXXI.).

cords belonging to each capellary leaf are plainly differentiated at this early stage.

The ways by which the tracheæ may change their position from the inner angle to a central one in the cord, or to the opposite side, are at least three in number. The whole cord may twist round, as do the marginal cords of the pistil of Hellebore; or, secondly, it may divide into two which rotate, according to Van Tieghem, as in *Geranium longipes*; or the tracheæ may pass obliquely upwards through the phloëm, and come out at the other side, as do the marginal cords of the carpels of Ivy. This last method seems to me to be the more usual case with placentary, that is marginal, cords, which come up from the axis with the tracheæ oriented inwards, but which finally must supply cords to the ovules, which lie on the opposite side of them*.

Undifferentiated or Arrested State of Carpels.

This feature plays a very important part and tends to obscure greatly the proper interpretation where cohesions and adhesions are concerned; for I believe that with rare, even if there be any, exceptions the apparently central medulla with the circle of marginal or placentary cords of a pistil is entirely due to the fusion of the margins of the carpels, the epidermides being arrested, so that the combined hypertrophied mesophylls form the central parenchymatous column of axile placentations. This is not only testified to by the arrangement of the tracheæ, but by the fact that the central mass often divides up into as many pieces as there are carpels, in the upper part of the ovary. Thus, comparing figs. 1 and 2 with figs. 3 and 4 of *Gladiolus* (lx.; Pl. XXXII.), it will be seen that the cords in the centre of fig. 1 look like those of an ordinary endogenous stem; but that they are potentially marginal is evident, as the dorsal carpellary cords are likewise present. Fig. 3 shows how the central tissue breaks up into three pieces belonging to the three carpels, no axis proper at all being present.

Another and conspicuous instance of arrest is seen between an inferior ovary and the receptacular tube into which it is merged; so that the internal tissues of the two organs become confluent,

* For a description of Hellebore, *Impatiens*, and Ivy, see 'Origin of Floral Structures,' p. 64 *seqq.*

as in the Currant. In the Ivy (XXXI., Pl. XXVIII.) the cords of all the whorls occur together, so that the inferior ovary of that plant contains on the circumference cords belonging to the calyx, corolla, and stamens, as well as the dorsal cords of the carpels, the marginal carpellary cords being near the middle; while all that is differentiated of the ovaries is the inner epidermis of each ovary-cell with its ovule.

One can therefore only draw a line passing round the dorsal cord, including the ovary-cell below it and the two adjacent marginal cords as well, to pronounce how much belongs to a single carpel. I would not hesitate to call everything included within this imaginary circle as foliar; so that nothing would be axial except the boundary, *i. e.* the epidermis and a certain amount of subjacent tissue; while nothing in the middle whatever would be axial. The above description will be better understood by referring to the figures given below; as e. g. *Calendula* (XXXVI., Pl. XXIX., p. 184), *Gladiolus* (LX., Pl. XXXII., p. 195), &c.

The Cohesion of Carpels.

The important feature of the arrest of development which takes place whenever two organs are congenitally united, cannot be too emphatically emphasized, as much confusion has arisen in consequence of a want of recognition of this fact, especially with regard to the nature of the receptacular tube. This arrest will also quite interpret the origin of the basilar ovule as well as of the free-central placenta of the *Primulaceæ* *.

Parietal Placentations.—As might be anticipated, there is difference in the distribution of the cords of carpels which are provided with parietal and axile placentas respectively. In the latter case the rule is for the outermost branch of the triple group, or of the "horseshoe"-shaped group belonging to each carpel, to become the dorsal cord, and the ovary-cell to appear between it and the other two remaining portions, which may be fused together to form one of the central axial or marginal carpellary cords (e. g. *Gladiolus*, LX.; Pl. XXXII.).

When, however, the carpels have a parietal placentation, as in *Reseda* (IX.; Pl. XXIV.), after supplying the stamens, a more or

* As these various results of arrest of development under cohesion have been fully discussed, I must refer the reader to my book, 'Floral Structures,' for details: see Index, "Arrest."

less complete ring is formed by "closing up." This, then, breaks up into two, three, or more groups for the placentas, with intermediate smaller cords for the dorsal. In *Ribes* (XXV. 5; Pl. XXVIII.), which has a receptacular tube, there are four additional cords present besides the dorsal and marginal carpellary. These four supply part of the perianth and are inserted in alternating positions with the four carpellary cords. This may be likened to the way in which a leaf of this plant is inserted on the branch. It has three cords in the petiole which pass down the axial cylinder, while intermediate ones pass up the stem between them.

Certain anomalies have long been noticed in the structure of the fruit of *Papaveraceæ* and *Cruciferæ*, especially as to the character of the placentas with the stigmas superposed to them. To endeavour to arrive at some interpretation of the anomalies, we must compare them with the behaviour of an original or *potential* carpellary cord while within an axis. For at this point we find marked differences between the cords of these orders and those of others, such, for example, as of Hellebore, *Eranthis*, or Aconite. In these latter a cord in the axis, which is destined to give rise to a carpel, divides into three branches, one being dorsal, the other two marginal or placentary, while the ovary-cell appears between them (*Eranthis*, IV. 6–9; Pl. XXIII.). In *Papaver* (V.) and *Eschscholtzia* (VI.; Pl. XXIII.) a certain number of cords appear *which at once supply the placentas* and do nothing else. They do not divide into triplets; nor, if we compare these with *Viola* (VIII.) and *Reseda* (IX.; Pl. XXIV.), which have parietal placentas, do we find, as in them, distinct dorsal cords. In these latter genera, besides the presence of large placentary cords, *there are smaller dorsal ones alternate in position with them.* Hence it would seem that in Cruciferous and Papaveraceous plants we have an extremely arrested or undifferentiated condition of the carpellary cords; so that the large cords of the Wallflower which stand between the longer pair of stamens (VII. 7) only develop into a pair of closely approximated placental cords with no differentiated dorsal cord at all. Hence the carpellary leaf which this cord ought to belong to would, theoretically, assume the form of the needle-like leaf of a Pine; but only possessing two marginal cords and no dorsal one (like the petal of a Composite). The consequence is that the stigma arising from these two approximate foliar edges will necessarily stand directly over the placentas.

The two pairs of small cords in front of the lateral stamens (VII. 7) might be regarded also as two abortive placental cords. This is countenanced by the fact that in *Tetrapoma* a stigma arises over the summit of them, just as two extra stigmas are borne by the pistil of *Eschscholtzia*. The function of these lateral cords is now altered for the simple purpose of nourishing the valves, just as the extra cords between the placentas do the same in Poppies.

The result is that while the, so to say, "valvular carpels" of the *Cruciferæ* are broad and devoid of placentas and stigmas, the others which bear the placentas are narrow, and the dehiscence between the carpels takes place along the lines of marginal sutures.

Free Formation of Tracheids.

The system of cords formed in the wall of the ovary of Poppies, alternating with the placentas, originates quite freely from meristematic tissue embedded within the parenchyma. They have no connection with any cords arising from the axis from below. After supplying the stamens (V. 5; Pl. XXIII.) nothing but the placental cords exist (V. 6), and the elaborately ramifying cords which subsequently appear (figs. 7, 8) arise quite independently within the wall and branch upwards and laterally as well as horizontally towards the central ovarian cavity (fig. 8).

The only other instance known to me of a group of tracheids originating freely, is a pair of star-like clusters between the ovarian cords in the *Boragineæ* (XLVII. and XLVIII.; Pl. XXX.).

Honey-secreting Glands and Disks.

These may be formed anywhere. All the floral organs are capable of giving rise to them, though the floral receptacle and receptacular tube probably furnish the greater number. In no case have they any vascular structure strictly speaking proper to them, as is the case with foliar organs. With rare exceptions, they consist of modified epidermal and hypodermal tissue with not even any associated cords of neighbouring organs. In the male flowers of *Lychnis dioica* (XII. 8, 9; Pl. XXV.) and *Buxus sempervirens* (LIII. 9; Pl. XXXI.) the nectary occupies the position of the pistil, but the vascular system belonging to that organ is atrophied and only reaches the base of the secretive tissue. In the *Labiatæ* (XLIV. 6, XLV. 2; Pl. XXX.) the dorsal-carpellary cord spreads out and forms a network behind the disk or gland, but contracts

again on passing up the outer wall of the ovarian cell, forming a very curious arrangement as seen in a transverse section. It may be the means of supplying the hypertrophied tissue of the gland with nourishment; but the gland itself is only an expansion of the superficial tissue at the base of the ovary.

With inferior ovaries the glandular structure is mostly the base of the styles, as in *Umbelliferæ* and *Caprifoliaceæ*, or the exposed part of the summit of the ovary, as in Ivy, or both may assist in the formation of it. A curious case is the septal glands of some Monocotyledons (LVII. 10*; LX. 3; Pl. XXXII.). These arise from a partial differentiation of the two epidermides of the walls of the carpels in contact, which together constitute a septum of the ovary †.

I have elsewhere described what appears to me to be a probable origin of glands, namely the irritation set up by insect agencies; so will refer the reader to my work on 'Origin of Floral Structures,' chap. xvi. p. 140.

DESCRIPTION OF FIGURES.

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† See Mr. E. H. Acton's paper, "On the Formation of Sugars in the Septal Glands of *Narcissus*," Ann. of Bot. vol. ii. p. 53.

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I. RANUNCULACEÆ (Pl. XXIII.).—I. CLEMATIS VITALBA. The pedicel usually contains from five to eight cords arranged in a circle (1). They then begin to spread out and become fan-shaped (2), multiplying by lateral chorisis, until a complete circle is seen in section (3). This gives off three or four branches to each sepal. The ring continues to increase by radial chorisis and small cords are thrown off for the stamens, each issuing from a sort of bulbous base (4 and 4 *a*). Figures 5 and 6 represent two sections near the apex of the floral receptacle cutting through the carpellary cords. Of these there are but few, sometimes only five are left (6), thus revealing their phyllotactical origin. As soon as the carpellary region is reached, the branches increase in thickness in a marked manner (7, 8) before sending off slender cords to the carpels. This curious augmentation is well seen in radial and tangential sections (7, 8). The cord on reaching the base of the carpel divides, sending off one branch to the apex of the style, the other ascends the margin of the carpellary leaf and supplies the single pendulous ovule with its cord (9).

II. ANEMONE CORONARIA.—The peduncle about an inch below the involucre agrees closely in its anatomical structure with that of *Narcissus*, *Ornithogalum*, &c., for it contains two somewhat irregular circles of cords around a lacuna (1), those of the inner circle being considerably the larger. On approaching the involucre the cords increase in number and unite in various ways. Figure 2 represents three cases. The branches sent off to the circumference enter and ramify within the three leaves of the involucre. After having done this, the axial cords first resume their former arrangement, as in fig. 1; they then form a single circle, by the smaller cords becoming intercalated between the larger of the previously more central ring. Each sepal now receives its supply of cords and the ring closes up again, increases by chorisis, and behaves as in *Clematis*.

III. RANUNCULUS FLAMMULA.—In the flower of this species, which is somewhat degraded, I found in one instance, but did not succeed in repeating the observation, that the papillæ of the

stigma were remarkably long, being suggestive of an approach to an anemophilous condition. Around these papillæ the pollen-tubes clung and twisted just like tendrils (1). Figure 2 represents a portion of a staminal whorl, the filaments have a contraction at the base, while the receptacle has a papillose surface.

The cord which supplies a carpel divides at first into two branches, one being dorsal, the other marginal or placental. The latter supplies the basal ovule with a branch and then passes over the ovary and curls backwards, finally joining the dorsal cord near the summit (3).

IV. ERANTHIS HYEMALIS.—The peduncle contains a single circle of large and small cords surrounding a central lacuna (1). After supplying the involucre the ring re-forms and then the cords increase till they form a complete pentangular prism (2), which sends off five branches to the sepals; the method of supplying the stamens is the same as in other cases. On arriving at the summit of the receptacle the remaining cords are at first circular (3); they then become grouped into triplets (4), each group being finally enclosed in a quadrangular mass of tissue, these masses, which vary in number, being all united by their bases (5). Each of them now becomes rounded and isolated, containing three cords (6). The tracheæ are central in position. One cord separates from the other two (7) and becomes dorsal (8); the others are placentary (9).

II. PAPAVERACEÆ.—V. PAPAVER RHŒAS.—The pedicel contains a circle of large and small cords (1). These increase until a complete circle is formed (2, 3). A large number of cords are then given off, which branch in a dendritic manner towards the circumference in order to supply the two sepals (3) and the four petals (4, *p*). The somewhat disarranged circle now closes up again and, becoming symmetrical, proceeds to supply the stamens, just as in *Ranunculaceæ* (5, *st.*). Just below the pistil, sections show from five to ten large cords which stand in front of, and are destined to supply, the placentiferous plate-like processes (6). Intermediate with these cords there are at first no tracheids at all, but a branching meristematic process can be seen inserted in the cellular tissue (7). This will be differentiated into independent groups of tracheids (7 *a*), finally branching in all directions, especially towards the ovarian cavity (8, *tr*) and up the wall of the ovary. Sections a little higher up than that represented in

figure 8 show the cords running vertically upwards, there being three or more together in different pistils (*cf.* 9 and 10, *tr*). The placental cords send off innumerable branches to the ovules scattered over the vertical walls of the placentiferous plates; these consist of a spongy parenchyma and serve as conducting-tissue for the pollen-tubes.

Decaying capsules with the skeleton exposed reveal the structure very well, by showing how these extra tracheids terminate above, just below the "pore," and fail to reach the axis below, but are suspended by lateral branches which unite them to the placental cords.

The only other instances known to me of an entirely independent origin of tracheids are certain star-like clusters which arise freely between the positions of the ovary-cells in the *Boragineæ* (see XLVII. 6, 7; and XLVIII. 2; Pl. XXX.).

VI. ESCHSCHOLTZIA CALIFORNICA.—This flower has a form of receptacular tube with the pistil free in the centre. The distribution of cords is not without some resemblance to that of *Prunus*. The pedicel contains a circle of cords (1). These begin to increase by radial chorisis till a tolerably complete circle is formed just below the commencement of the funnel-shaped tube (2). A considerable number of cords now pass off to the circumference to supply the sepals (3 and 4, *s.*). Another portion of the ring separates for the petals and stamens (4, *st.*, 5, 6), and a third ring becomes isolated within them, which belongs to the pistil (4). The stamens are supplied in various ways. The cords first appear in clusters as the tracheæ of particular ones isolate themselves (4), and they separate either by radial or tangential chorisis, or else, so to say, break up into groups of three or four (5, 6). The cords of the four petals are not distinguishable.

The pistiline group of cords isolated in the middle consists of eight cords at first, arranged in the form of an ellipse (4), each of the two (at the ends of the shorter axis) facing one another separate into two or three (7, *pl.*). If there are two, each belongs to a placenta (8); if three, then the central one appears to supply the ovules (7). The other large cords send up small branches (9), all of which help to supply the ovarian walls (8). As the ovary contracts at the base of the style, the cords form four groups which then pass off into the four styles (10). This appears to show that the cords at the extremities of the *long* axis are *potentially* marginal or placentary; and as *Eschscholtzia* has sometimes

six styles, it looks as if other cords might be marginal as well, but are now arrested so as simply to supply the wall of the ovary, just as do the alternate branching systems of *Papaver*.

III. CRUCIFERÆ (Pl. XXIV.).—VII. CHEIRANTHUS CHEIRI. The pedicel of a Wallflower has five cords (1). These multiply and change from a circular to an elliptical arrangement (2, 3). The two cords at the extremities of the long axis are the first to pass off to supply the *lateral* sepals (4); not the antero-posterior pair, which, although overlapping the lateral sepals in æstivation, receive their cords after them (5). The section now shows a quadrangular arrangement, the four corners supplying the four petals with their cords (5, 6, 7, *p.*), while fresh ones appear superposed to the lateral sepals by the closing up of the cylinder. These now prepare for the two shorter stamens (6, *l.st.*). The glands (G) appear between the sepals and these stamens. The cords for the taller pair now appear *close beside those of the petals* (6, 7, *p.st.*); while another group of tracheæ stands between the two cords which belong to the taller pair of stamens (7, *pl.*). This group becomes the marginal cords of a carpel.

I have italicized the words above in order to emphasize the fact that the pairs of longer stamens are not due to chorisis from an originally single stamen, as there is a cluster of carpellary tracheæ *between* them, as shown in figures 7 and 8.

The pistil is provided for by the *two* groups, one from each, *i.e.*, the anterior and the posterior side (7, *pl.*), and *two pairs* of cords situated laterally. Their origins become clear, inasmuch as these lateral pairs had at first the staminal cord between them; while the posterior and anterior carpellary cords stand between the two stamens of each of the larger pair. The pairs of lateral cords pass up into the valves (9, *v.*), while the others nourish the placentas and ovules (9, *pl.*). In the style, the latter have dwindled to minute cords, the former cords having become the larger ones (10).

The disconnected origin of the four carpellary groups countenances the idea that they represent four carpels, as illustrated by *Tetrapoma*, which has four styles. This genus is therefore comparable in this respect to *Eschscholtzia* in the *Papaveraceæ* *.

* I have discussed the origin of the binary and quaternary features of a Cruciferous flower in my work 'On the Origin of Floral Structures,' p. 31, to which I would here refer the reader; as well as in a paper "On the Structure of a Cruciferous Flower," in Trans. Linn. Soc. 2nd ser. (Botany), vol. i. p. 191.

IV. VIOLACEÆ (Pl. XXIV.)—VIII. VIOLA TRICOLOR.—The peduncle of a Pansy has four large cords (1). These increase and form a complete circle, seen on a level through the basal appendages of the sepals (2). They now throw off five large cords for the sepals (3, *s.*); the three posterior being given off rather earlier than the two anterior, *i. e.*, on the same side as the calcarate petal (3, *p.*). A section a little higher shows the five cords ramifying in the lobes of each sepal (4). The next section reveals a very unusual condition of things, for instead of the remaining cords closing up and forming a circle again, they produce a sort of platform of interlacing tracheæ embedded in phloëm (5). These then arrange themselves into a somewhat triangular mass with three small ones alternating with them (6). The "corners" rise up and supply the three placentas (7, *pl.*); the three latter (instead of running straight up the wall of the ovary as will be seen in *Reseda*) bifurcate (9, *a*), and the branches run up beside the placentas, leaving a space devoid of cords (8, 9, *sp.*). This allows the ovary to break into three valves; an impossibility in Mignonette, as in that plant the dorsal cords run up midway between the placentas and are connected by transverse cords. Figure 10 represents a general diagram showing the distribution of all the cords.

V. RESEDACEÆ (Pl. XXIV.).—IX. RESEDA ODORATA.—There are about eight cords in a pedicel (1). These multiply, but instead of forming at first a complete ring, the vascular cylinder appears deeply indented (2). The object of this becomes clear in the next section, in that it is a preparation for forming *two* very perfect circles of cords (3, 4). The outer one sends off twelve cords for the sepals. Each sepal has, besides its midrib, a branch from each of the forking intermediate cords; so that there are three cords in each sepal (as shown by the bracket, 4, *s.*). The corolla being so extremely atrophied, the petaline cords are not recognizable. The outer circular series now sends off cords for the numerous stamens; while the cords of the inner circle combine to form six groups (5–7), three, the larger ones (*pl.*), supply the placentas, and three smaller form the dorsal cords (*d.*). The former send off horizontal branches to meet the latter (8). Hence, not only are there no vacant spaces down the wall of the ovary as in *Viola*, where the ovary can split into three valves, but in *Reseda* it is prevented from doing so by the horizontal connecting-ring. It is compelled, therefore, to open only at the summit.

VI. CARYOPHYLLEÆ (Pls. XXIV., XXV.).—*Tribe* Sileneæ.

x. DIANTHUS BARBATUS.—An oval ring of cords in the pedicel sends off two pairs of cords for the bracts (1). The rest then close up for the calyx (2); for this, ten principal cords are given off (3 and 4, *s.*); and the ring closes up again, forming a sub-pentagonal arrangement (4). This now provides five isolated cords for the sepaline stamens (5, *s.st.*), and the five petals are separated off nearly at the same time (5, *p.*); so that another pentagon is left. Between this and the petals is the cellular disk (7, D). Each petaline cord subsequently gives rise to a staminal (6, *a* and *b*).

The central pentagon now contracts (7), changes its form, and breaks up into four masses, arranged in an oval manner (8). The two nearest the centre divide into four (9, 10), of which two coalesce and form a central placentary group (10, 11, 12, *pl.*), at which period the ovarian cavities appear (10–12, *ov.*). Hence the axis has now become extinct. Four cords are now isolated on the circumference, two being dorsal and two situated at the ends of the septum (11). The dorsal also multiply by radial chorisis and give rise to smaller cords (11). The central cluster now becomes cruciate (12) in order to supply branches to the four placentas corresponding to the four margins of the two carpels of the pistil (13).

XI. SILENE INFLATA (Pl. XXV.)—There are five cords in the pedicel of a flower of this plant. It furnishes a case in which the pericycle is particularly well seen. It is indicated by a circular band in fig. 1. The cords increase till a complete circle is formed. This gives off five strong cords and five smaller ones opposite to the petals for the calyx (2). These rapidly divide into twenty; the remainder close up into a pentagonal prism (3), which now separates into two series of five each, the cords assuming a horseshoe shape (4). The outer cords supply the five petals (5, *p.*), each of which gives rise to a staminal cord (5, *p.st.*); the cords of the five calycine stamens having also appeared (5, *s.st.*). A central ring is left: this breaks up into three large placentary cords and three smaller dorsal ones (6) alternating in position, just as in *Reseda* (IX. 5–7). The three larger (7, *pl.*) close up, approach the centre, and gradually become fused together, having the tracheæ scattered about the middle of the phloëm (8). The latter finally arrange themselves into three radiating lines

to supply ovular cords (9, 10). The circumferential cords, *i. e.* originally the three outer and dorsal (7, *d.*), have increased in number (8–10). Here, therefore, there is no trace of an axial system after the breaking-up of the circle in fig. 5 into the three larger and three smaller cords (6). I would, therefore, draw the line between the axial and carpellary cords, between figures 5 and 6; for in the latter we have the three carpellary systems clearly differentiated; although the tracheæ are *within* and the phloëm *without* in each cord, just as if they were really axial and surrounding a central medulla.

Figure 10 represents a section higher up the ovary, and shows the placentas, which are of course double, to which the ovules are attached.

XII. LYCHNIS DIOICA.—The pedicel of the male flower contains four or five cords which lie on a circle (1). They increase till they form a complete ring (2), which then provides ten cords for the sepals (3). Two portions (4, *p.*), one on each side of the marginal cords of the sepals (4, *m.s.*), are set apart as petaline cords, which thus retain their tracheæ in pairs, thereby indicating their origin (4, 5, *p.*). About five masses of phloëm with scarcely perceptible tracheæ form a broken ring within these petaline cords (5), and give rise to the ten stamens (6, *st*). Figures 7 and 8 represent vertical sections. In the cup-shaped depression within the stamens there is formed a honey-gland (8, 9, G); but the rudiment of the pistil in no way contributes to its formation, as it contains no cords.

It should be observed that the petaline stamens are not given off from the petaline cords in so pronounced a manner as in *Dianthus* (x. 5, 6); but they appear to be formed from the more central masses of phloëm instead, and quite independently of the petals (5, 6).

In the female flower the cords at the base of the calyx form a complete ring and give off ten cords for the sepals (as in fig. 3). Then a pentagon with five exterior and prominent cords remains: these latter are for the petals (10, *p.*). As soon as they, together with the rudiments of the staminal cords, have become isolated (11, *rud.st.*), another pentagon then appears, alternate in position with the former (12). It consists of five large clusters of tracheæ and five smaller ones. These are for the carpels, already thus sketched out; for the larger groups will become

differentiated into anti-petaline placental cords and the smaller into anti-sepaline dorsal ones. Hence the axis has no longer any part in the structure of the pistil.

The five large placental groups of tracheæ assume at first a tri-lobed form (14); then the shape of U's or V's, the central lobe (*m*) forming a separate cord situated in the angle. The result is that the two rows of ovules belonging to each carpel ultimately face the mid-rib of the carpels (19); the margins have, so to say, met in the middle and then turned outwards again—not unlike what takes place in *Cucurbitaceæ*, but to a less extent. The conducting-tissue between the rows of ovules which faces the remnant of the septa is therefore, as also the whole of the central mass of parenchyma, simply the hypertrophied margins which are all fused together in forming the column.

As the distribution of the cords is somewhat complicated, it may be advisable to explain the details a little more fully. The reader must first carefully compare figs. 14, 15, and 16, and observe how the central lobe marked *m* (14, *m*) becomes isolated in (15) and (16, *septal* or *m*), then passes finally to the circumference, as a septal or marginal cord (17–19). It will be seen that the 5 dorsal cords (13, 15, 16, 17, *d.c.*) alternate with them.

The most important point, however, to observe is that one branch of each of the two adjacent "U's" meets the other and forms a single line. Thus the two branches under *d.c.* in figs. 15 and 16 coalesce and form the uppermost arm of the pentagon (17), and finally the ray of cords (19) leading to the ovules. Fig. 18 shows the ovular chambers with the septa still existing. In fig. 19 the septa have broken away, the ovules are now present and face the dorsal cords.

M. Ph. van Tieghem thought that after the tracheæ had coalesced to form the median rays (leading up to the ovuliferous placentas), an axial cylinder still remained in the middle. "En même temps, les angles rentrants du système devenus libres reconstituent dans le parenchyme central, un circle de dix, faisceaux environ, régulièrement orientes et auquel nous devons par conséquent reconnaître le caractère d'un axe" *. I must confess that I never could discover anything of the sort. The tracheæ are remarkably small, and after the adjacent arms

* *Op. cit.* p. 56.

of each pair of U's or V's have coalesced they form a thin broken line of black dots in a radial direction (18), while here and there a stray trachea appears in an isolated position; but there is nothing at all, as it seems to me, to justify the description given above. Hence I regard the axis as totally wanting, and the central axial column as entirely due to the hypertrophied margins, just as in *Pelargonium*.

VII. MALVACEÆ (Pl. XXV.).—XIII. MALVA SYLVESTRIS and M. MOSCHATA.—There are five cords in the pedicel of the Common and Musk Mallows (1). These increase till a complete circle is formed (2), from which three are given off for the epicalyx (2, *ep.c.*) and several to each sepal. Above the calyx five quite separate and large cords are formed, with the tracheæ somewhat irregularly disposed within the phloëm (3). They become united, when each breaks up into five (4, 5). The outermost is a petaline (*p.*), the next two are staminal (*st.*), and the innermost pair (*c.*) are carpellary (5).

The petaline cord first divides into three (6, *p.*) by radial chorisis, then into five, or even seven may be produced. The ten staminal cords now pass up the filamental column, five arranging themselves exactly opposite the petals and five alternating with them, and therefore opposite to the sepals (7). The former now divide by tangential chorisis into two (8); subsequently a third is given off, while the sepaline now divide into two (9). The others repeat the process, so that thirty antheriferous filaments are finally produced. Figure 10 shows how the original cord divides into a pair. Ph. van Tieghem described *Abutilon pictum*: the process is much the same, only each staminal cord gives rise to six antheriferous branches; so there will be sixty in all *.

The carpellary cords early spread away, and together form a regular circle of ten cords (6, *c.*) at least. Each of these divides into three, a central cord passing off to become a dorsal carpellary (11, *d.c.*); while one supplies a cord to the single ovule, the other ultimately stands in front of a septum (11).

VIII. HYPERICINEÆ (Pl. XXVI.).—XIV. HYPERICUM ANDROSÆMUM.—In this species there are five phalanges of stamens, each of which is more easily detected, as being of double origin, than are those of species having three phalanges only.

* Recherches sur la Structure du Pistil, p. 30, pl. ix. figs. 5–9.

Commencing with a complete cylinder in the pedicel (1), it supplies ten or more cords for the five sepals (2). There remain five large cords of a horseshoe shape (3); the central or terminal part of each supplies a petal (3, 4, *p.*), before entering the latter it branches in a pedate manner (5) forming the large number of veins of the petal. There now remain ten cords more or less connected by portions inwardly convex (6, *c.*). They are arranged in pairs (6, *ph.*). Each pair gives rise to a phalanx, which is thus seen to be of double origin.

It would seem that the way the petaline cord increases to furnish the petal (5) is repeated in the case of the stamens, though each branch now enters a separate filament.

As soon as the stamens have been supplied, the five remaining groups commence to coalesce into three, by two pairs uniting (7), forming three oval-shaped masses (8, 9). These supply the dorsal and placental cords as shown in figs. 10, 11. In figure 12 the ovary-cells are just appearing (*ov.*), while the dorsal cord trifurcates.

In small-flowered species with three phalanges, such as *H. quadrangulare*, *montanum*, *tetrapterum*, and *perforatum*, examined, there are ten principal cords for the sepals (as in figure 2), the petals being also formed as in the case described; but now the five cords at once coalesce into three groups (13), so as to furnish the three phalanges of stamens. The phalanges having been supplied, there remain three masses of cords between them. These supply the pistil as described above (14).

Fig. 15 is taken from *H. montanum*, and shows particularly clearly the distribution of the cords for the petals (*p.*), the two branches of each phalanx (*ph.*), while the remaining portion is destined for the carpels (*c.*). These five carpellary cords will ultimately coalesce into three, as described above.

IX. GERANIACEÆ (Pl. XXVI.).—*Tribe* Geranieæ. XV. GERANIUM ROBERTIANUM has five cords in the pedicel (1). These bifurcate (2) and increase till a complete ring is formed which sends off from eight to ten cords for the sepals (3). Some sepals are slightly smaller than the others, so that the ten cords are not distributed equally within the sepals (4, *sep.*). Five glands (G) appear on the axis in front of the sepals; these have no cords, and are merely cellular protuberances. The petaline cords now appear, and there are ten staminal. These, however, are so

minute and the whole of the tissue is so densely charged with chlorophyll, that they cannot readily be seen. Their positions are indicated by dots (4).

Five carpellary cords arise in front of the petaline. Each of these, as also occurs in *Erodium* and *Pelargonium*, first divides into three (5, *a*): thus, the middle cord passes off as a dorsal carpellary (*d.c.*), while the other two portions of each of the original cords divide again (5, *b*); the two outer, which result from this last division, unite respectively with the adjacent portions of the nearest carpellary cords and stand between the placentary cords (6, *i.c.*), and so form intermediate cords (5 *b*, *i.c.*, and 6, *i.c.*). The two inner portions (5 *b*, *pl.c.*) coalesce, as soon as the dorsal cord (5 *b*, *d.c.*) has passed off, and form the single placentary cord (6 and 7, *pl.c.*) in front of the ovary-cell.

XVI. ERODIUM CICUTARIUM.—The peduncle of the umbel contains five cords (1), one being very small. This last is destined for the bract. The other four increase in size and each becomes at first fan-shaped; then, by continuously branching, the outermost tracheæ meet, and so a complete circle is formed (2). These supply the four pedicels (or else three, by the coalescence of two) of the umbels with their axial cylinders, each of which soon consists of five cords (3).

The five cords of the pedicel increase and form a ring. Ten cords are given off for the sepals; five of these bifurcate (4) so that the sepals receive three each (6, *s.*). The passage from fig. 4 to fig. 5 much resembles that from fig. 3 to fig. 4 in *Geranium*. The staminodes, however, have no cords (6, *stde.*). Figures 7, 8, and 9 represent sections below and at the base of an ovary-cell. In fig. 7 the cuneate cord (5) has divided into three, one is passing off to become a dorsal cord (7, *d.c.*). Each of the remaining pair divides, as in *Geranium*; the two inner halves of the cords coalesce to form the placental cord (8, *pl.*). The other two unite with their nearest neighbours and form intermediate cords between the ovary-cells (8, 9, *i.c.*). These more or less lose their tracheæ and become sclerenchymatous in character.

GERANIACEÆ (Pl. XXVI.).—*Tribe* Tropæoleæ. XVII. PELARGONIUM ZONALE.—The pedicel has ten cords forming a perfect circle (1). As the base of the flower is approached, it spreads into a more elliptical form (2). As soon as the base of

the honey-tube appears, three cords are seen isolated from the remaining groups. The one beyond the cavity is for the posterior sepal (3, *s.*). A little higher the circle of cords at the other end of the axis increases to about twenty in number (3); and while a certain number travel outwards for the sepals and petals, and stamens in part (3), the rest close up and soon form a perfect circle in the middle (4). Two petaline (posterior) cords now divide (4); one half remains petaline, the other being transferred to a sepal (*cf.* 4 and 5). Comparing figures 3, 4, and 5, it will be seen that when the posterior sepal was provided for, the cord had increased in size (2) and gave rise to three separate cords, which now appear on the *inner* side of the cavity (4). These are for the cords of two petaline and one sepaline stamen. The ring now provides for four more perfect stamens; the three filaments, which bear no anthers, having only an extremely minute cord or none, indicated by dots in fig. 5. They are the three anterior and petaline stamens.

The relative positions of the anthers on maturity is in strict adaptation to insect fertilization. The two posterior and petaline face each other, *i. e.* right and left of a median line, while the filament of the posterior and sepaline stamen is declinate, bending forwards and downwards so as to bring the anther into an upturned position. The two pairs of sepaline stamens face each other in the same manner as the first pair; so that while six are introrse, one, the posterior sepaline, is really extorse.

In preparing for the pistil the innermost circle consists of five cords (6). These become trilobed (7) and are situated opposite the petals (5). The central cord becomes the dorsal carpellary (7, 8, and 9, *d.c.*). Of the other two, each bifurcates (7–9); the innermost branches coalesce to form a somewhat crescent-shaped placental cord (10). The others travel outwards and coalesce with the corresponding branches of the neighbouring systems, just as already described in the other genera of this order (8, 9, 10). The first described pairs uniting have thus formed five cords of double origin in front of the ovary-cells (9, 10), alternating with five others intermediate in position. These are often largely composed of phloëm with the tracheæ ultimately obscure (10).

Above the ovary-cells, at the base and thicker portion of the style, a section shows five solid circular buttresses, the tissue of which is continuous with the central parenchyma, in the middle of

which is a lacuna formed by rupture. In the depression between the buttresses a small portion of the style and conducting-tissue forms a sort of bridge.

It is in this homogeneous mass of ground-tissue that we have a complete fusion of the hypertrophied borders of the carpels, which have thus entirely lost their individuality. The axis proper disappeared as soon as the tracheæ became disunited, as in figure 7 (*i. e.* it ceased to exist between figures 6 and 7). Hence the dotted lines in figure 9 radiating from the centre mark the ideal boundary of each carpel, and the line across the base of the ovary-cell shows the place where the rupture will take place when the fruit is mature. The column, or so-called "carpophore," remaining, is therefore entirely carpellary in its origin *.

XVIII. TROPÆOLUM MAJUS (Pl. XXVII.).—The pedicel of this plant, like that of *Pelargonium*, contains ten cords (1), which form a perfect circle. The cords are peculiar in having a zone of large cells between the tracheæ and phloëm (1 *a*). Ten cords are given off to the calyx, the seven on the anterior side being united by transverse arcs (2). Five cords are given off to the petals in regular order (3, *p.*). Of the ten stamens, which theoretically belong to the flower, two, viz. one posterior and one anterior, are suppressed, the eight others receiving their proper cords (4). Three clusters of somewhat branching cords are isolated in the centre (4). Each of these first breaks up into five (5), all of each group being oriented towards a common centre, respectively. They increase to seven, surrounding the ovary-cells, with one much larger marginal cluster of tracheæ embedded in phloëm (6). Each ovary-cell now becomes lobed round the cords.

X. LEGUMINOSÆ (Pl. XXVII.).—XIX. CYTISUS SCOPARIUS. The pedicel of the Broom contains a perfect and compact circle of cords (1). The first indication of an approaching irregularity consists of an unsymmetrical departure of three cords on one side (2) and then three on the other (3). Those on the posterior side become joined by loops. The central one branches, so that five cords are discovered (4). Three of these enter the circular base of the standard or vexillum (4, *vex.*). On the anterior side, besides the original three, two others are given off between them,

* For further details, see 'Origin of Floral Structures,' p. 65.

making five, *i. e.* two petaline and three sepaline, which are now united by lateral branches (4). Two small cords are given off from the circle to supply the alæ or wings.

Figure 5 represents a section between the petals and stamens. The central cord has trifurcated, so that there are five branches in the vexillum (5, *vex.*). These ultimately increase to nine (6, *vex.*). The same figure (5) also shows the bases of the three cords on the posterior side belonging to the vexillum. Two cords are now present for each ala, connected by loops; while two cords will appear on the anterior side, destined for the carina or keel petals.

The oval remaining in the middle will supply the ten stamens and one carpel. How figure 6 is arrived at may be best seen from the following sections of flowers of other genera, where the process is the same (*cf.* LOTUS (XXI. 4–8), PISUM (XXII. 3–6).

XX. CERCIS SILIQUASTRUM.—The flower of this tree is remarkable for the entire freedom of its stamens. This is readily accounted for by the extraordinary large size of the honey-disk (D), which forms an oval ridge indented with ten sinuses, in each of which a stamen stands freely. They are therefore well apart, and can develop perfectly independent of each other.

XXI. LOTUS CORNICULATUS.—Figure 1 represents a section of a peduncle. Groups of cords finally separate to supply the pedicels of the umbels (2). Though they are at first horseshoe-shaped, they soon become circular (3). The circle now throws off ten cords for the sepals and petals with scarcely any pronounced irregularity and without the complications seen in *Cytisus* (XIX. 4). The stamens are given off, and a broken ring remains in the centre (5), a crescent-shaped cavity appearing on the anterior side for the honey-disk. This increases while the two halves of the broken circle give rise to dorsal and placentary cords respectively (6). The stamens, though diadelphous in the fully developed flower, are, as in *Pisum* (XXII. 5 and 6), monadelphous at first (7). The tenth stamen becomes free by the atrophy of the tissue on either side of it (10).

XXII. LATHYRUS ODORATUS (lettered *Pisum odoratum*).—A difference in the method of supplying cords to the whorls will be observed in figures 1–4; in that a section, such as figure 3, shows that the cords branch very rapidly; consequently the cords for all four whorls are seen *simultaneously* instead of in succession.

As in others, the stamens are monadelphous at first (5), but diadelphous subsequently—the free stamen carrying two small wings, which have broken away from the attenuated edges of the tissue which binds the others together (6).

In the formation of the pistil, it may be noted that, instead of there being three well-defined cords for the carpel, as occurs in so many plants, e. g. *Eranthis* (IV. 6–9), it is a complete circle which has to be utilized for one carpal (5). This would seem to show that there ought to be a whorl instead of only one carpel, as is of course always supposed to be the case, judging from the pentamerous pistil of *Affonsea*. It is interesting, therefore, to find that the distribution of the cords tends to corroborate this view; four being arrested, their cords are utilized for one only.

XXIII. CERATONIA SILIQUA.—In the pedicel of the Carob, the cords are arranged in a somewhat quadrate manner (1). They then become circular, and send off five for the sepals and five for the petals (2). The ten for the stamens are given off in a circular form, when a perfect cylinder is left in the middle (3). This becomes oval for the pistil (4). When the ovary-cell appears, the two placental and the dorsal cords are of considerable size, while a complete circle of cords surrounding the ovarian cavity is also developed. These branch and give rise to a circumferential series (5).

XI. ROSACEÆ* (Pl. XXVII.).—XXIV. PYRUS MALUS.—The Apple has a pedicel remarkably like a monocotyledon, in that there are a number of cords indiscriminately placed; but those on the circumference are the largest (1). In the case of the Daffodil, as in Anemone (II. 1), the larger cords are on the medullary side. These soon differentiate themselves into ten (2), five outer for the sepals (*s.*), and five inner for the petals (*p.*); and a star-like pentagon is formed out of the remainder, the lobes being superposed to the sepals (2, *s.*). The numerous stamens are formed by radial and tangential chorisis of the petaline and sepaline cords, as shown in figure 3. The lobes of the pistiline pentagon (2) break up into triplets (as seen in figure 4). One forms a

* The remarkable feature of flowers of this Order is the presence of a well-defined and variously formed receptacular tube. P. van Tieghem has described and figured the anatomy of the tube of *Prunus Lauro-cerasus* (Recherches sur la Structure du Pistil, p. 40, pl. ix. figs. 20–24). I have fully discussed the nature of the receptacular tube, and the light thrown upon it both by Anatomy and Teratology elsewhere ('Origin of Floral Structures,' chap. x. p. 89).

dorsal carpellary, the other two are marginal, the base of an ovary-cell soon appearing between them (5).

XII. SAXIFRAGEÆ (Pl. XXVIII.).—XXV. RIBES COCCINEA. The peduncle of a raceme of this plant, just below the node at which a pedicel is given off, shows a certain number of cords stretching out to one side (1). The terminal or isolated cord belongs to the bract (2, 3, *b.*); while the rest form two small groups for a pedicel (3, *ped.*); the remainder close up to continue the peduncle (2, 3), while another "loop" soon appears for the next bract and pedicel, and so on. Eight cords, regularly placed, enter the pedicel (3, *ped.*). Two on opposite ends of a diameter increase: these are placentary cords (4, *pl.c.*). These then trifurcate and give off two apiece, so as to complete the number ten for the calyx and corolla (6). The sepaline cords give off the staminal by tangential chorisis (7, *a–d*).

XXVI. ESCALLONIA.—This differs from *Ribes* in that the cords are situated more irregularly, the pedicel containing a connected zone of cords instead of eight (1); this breaks up into an apparently confused arrangement (2). Then one observes that it is not the *placentary* cords which supply the two extra ones, as in *Ribes* (XXV. 5, 6), but *two* of the *outermost* (4*) of the two circles (3)—or, rather, irregular inner and outer sets of cords—which thus make up the number ten. The innermost portions of the original cylinder ultimately become massed together as placentary cords (5). The number eight occurring in these two genera is unusual, as the flowers are quinary, and seem to point to an ancestral condition of a quaternary arrangement; although the foliage is alternate, which would otherwise countenance the idea that no anomalous condition was to be expected.

XIII. CRASSULACEÆ (Pl. XXVIII.).—XXVII. SEDUM TELEPHIUM.—The pedicel contains a cylinder of about five or six cords (1). These increase and finally send off separate cords to all the whorls (2–4). It closes up at the base of the carpels, and then constitutes a very perfect circle, the tracheæ oriented as if axial (4); but the dorsal-capillary cords have already appeared beyond the now visible bases of the ovary-cells; consequently the carpellary and not axial nature of this central circle is revealed, notwithstanding its *apparently* true axial character. At a height where the ovary-cells are well formed, the ring has broken up

into six placentary cords with central tracheæ (5), which take up their positions in pairs in front of the septa, and thence send off cords to the ovules (6); the tracheæ again being oriented as if axial.

XIV. ONAGRACEÆ (Pl. XXVIII.).—XXVIII. FUCHSIA.—In the example examined there were eight cords in the pedicel oriented as in figure 1. Alternate cords multiply until twelve are formed (2, 3, 4). The bases of the ovary-cells have not yet appeared. In the case described by Ph. van Tieghem, the ovary-cells appeared immediately after fig. 1. As soon as the ovules are reached, according to Ph. van Tieghem, each of the eight circumferential cords are found to be doubled—the cords opposite the septa or sepaline giving rise to placental which send off branches along the septa, inwards; these then curve round to reach the base of the ovules. The dorsal and placentary cords are connected by transverse branches.

I did not, however, find this to be the case. It will be seen from figure 2, that four cords (*s.*) are larger than the others, and that it is only the intermediate ones (*p.*) which multiply. The four which remain isolated are sepaline (*s.*); and it is the petaline which give rise to the innermost set of four placentary cords (3, *pl.c.*), one cord remaining as petaline (*p.*); these pass inwards and stand immediately in front of the sepaline (4). The ovary-cells now appear, and the petaline cords behind them give rise to the dorsal carpellary as well as staminal cords (5, *st. d.c*); but it is not until the summit of the ovary is reached that the sepaline and petaline give rise to the two whorls of stamens. At the top of the ovary the eight central cords become fused together, the four sepaline remaining free (6). This arrangement is then continued up into the style.

XV. UMBELLIFERÆ (Pl. XXVIII).—XXIX. ANGELICA SYLVESTRIS.—In this order the peduncle contains a definite number of cords (1) which form a circular network at the base of the umbel. This latter then throws off cords for each pedicel (2). At the base of the ovary five cords pass up the "primary" ridges of each mericarp from base to apex, while two more or less coalesce and pass up the middle. Figure 3 represents a section at the base of the ovary-cells, showing ten cords passing outwards to the circumference with two placentary cords in the

centre. At the summit of the inferior ovary, the central or placental cords send off three branches, respectively—one to each ovule, and two to join the nearest cords (4).

xxx. Daucus Carota.—The diagram represents a section taken at the summit of the ovary, and illustrates the fusion of two cords on either side of each ovary-cell; so that the section (through the swollen bases of the styles, which form the so-called epigynous disk) shows only three, instead of five, cords in each mericarp.

As in the *Geraniaceæ*, the carpophore consists of the united marginal cords of the two carpels, so that it contains no part of the axis whatever.

It is worth while observing that of the two cords situated one at each end of the long axis, *i. e.* dorsal cords of the ovaries, one divides and supplies a sepal with its cord, the other also divides but supplies a petal.

XVI. ARALIACEÆ (Pl. XXVIII.).—xxxi. Hedera Helix.—The pedicel at first contains four cords (1). These increase till a complete ring consisting of ten cords is formed at the tapering base of the inferior ovary (2-5). These ten become fifteen (6) and then twenty (7), and are arranged in concentric circles. The outermost consists of ten, the other two of five cords each. The outermost cords supply the sepals and petals; the next, the stamens which are opposite to the sepals. The innermost are carpellary and opposite the petals. The number of ovary-cells varies from three to five. When there are three, the carpellary cords first approximate to form two pairs, leaving one free. They are finally reduced to three. They then become double in number (8), and while one cord passes to each ovule, the remainder pass up the style (9) *.

XVII. CAPRIFOLIACEÆ (Pl. XXVIII.).—xxxii. Lonicera Periclymenum.—The pedicel has a somewhat disconnected circle of cords enclosed in a definite pericycle indicated by a zone in the figure (1). The circle gives off ten cords (2). Five of these belong to the sepals, while the other five, becoming double, pass into the corolla-tube (3, 4); three being isolated in the middle as placentary (4). Of the ten cords in the corolla-

* For further observations on the structure of the flower of the Ivy, I would refer the reader to 'The Origin of Floral Structures,' p. 67 *seqq.* fig. 14.

tube, which becomes somewhat pentangular, five are staminal (5, 6, *st.*). The other five increase by radial chorisis. The section of the tube now becomes more elliptical, and the anterior surface is clothed with papillæ, showing that hypertrophy affects the anterior side much more than the posterior (7).

It is noticeable that while the staminal cords have the tracheæ situated centrally (6, *st.*), the other or petaline cords are oriented as if they were axial.

XXXIII. LEYCESTERIA FORMOSA (Pl. XXIX.).—The pedicel has eight or nine cords (1). These increase, giving off ten to the circumference, and retaining ten in the middle just below the appearance of the ovary-cells (2, *ov.*). As soon as these appear, five of the circumferential cords are situated dorsally, and five are intermediate (2). In the central space five of the cords stand opposite the septa (3); the others send off cords to the ovules and disappear (6, then 3). Higher up the axile placenta separates into five anchor-shaped structures, as seen in section, with a single cord in each each near the apex (4). At the summit of the ovary the central lacuna assumes a pentagonal form (5), and ultimately closes up to form the style. The sepaline cords are remarkable for having arched girdles, from which are sent off cords to form the veins in each sepal (6). This reminds one of a similar process in *Anemone* (II. 2), in which the bracts of the involucre are supplied with their vascular system. See also the alæ of *Cytisus* (XIX. 4, 6).

XVIII. VALERIANEÆ (Pl. XXIX.).—XXXIV. VALERIANA OFFICINALIS.—The pedicel has six cords symmetrically arranged (1); but they become unsymmetrical in the wall of the inferior ovary (2). On arriving at the summit two of them branch; these two branches, together with one of the original cords, enter the style (3), which terminates with three stigmas. Three of the other cords branch for the three stamens. The corolla has five of the original number. Fig. 4 shows a vertical distribution of the cords.

CENTRANTHUS RUBER.—The arrangement of the cords is the same as in Valerian to the summit of the ovary; but a horizontal vascular ring now connects the whole of the cords. From this zone cords are given off for the corolla. It is observable that a corresponding ring, resembling the stipular zone in *Galium*, is

formed at the nodes, though it does not supply cords for any stipules as in *Rubiaceæ*.

XIX. DIPSACEÆ (Pl. XXIX.).—XXXV. SCABIOSA SUCCISA. The pedicel contains a ring (1) which divides at first into eight cords (2), and when these pass to the circumference two others remain in the middle (3). The ovary-cell appears between them. Four of the cords belong to the sepals (4, *s.*), and four, alternating with the former, to the petals (4, *p.*). The staminal are given off by chorisis from the sepaline, *i. e.* if the flower be 4-merous. A flower not infrequently has five petals, which then reveals the origin of the normally irregular four-merous flower. It is desirable to compare it with a Labiate, for it shows that, although both have a "hood" and a "lip," they are constructed on different principles. In the Labiate, e. g. *Lamium album*, the hood consists of two petals and the lip of one, the lateral petals being atrophied, but both are present. In *Scabiosa*, figure (5) shows the originally quincuncial order of development, the fifth or innermost petal being atrophied. The stamen adjacent to it vanishes (represented by an O in fig. 5), so that when the flower becomes 4-merous, both the lip and the hood, each, consist of one petal only. The stamens are of course differently situated from those of the Labiatæ, and it is not the posterior stamen which disappears, as in that family; for it is one on the anterior side which is wanting in *Scabiosa*. A papillose gland is formed at the base of the posterior petal.

XX. COMPOSITÆ (Pl. XXIX.).—XXXVI. CALENDULA OFFICINALIS.—The peduncle of this flower contains twenty cords of different sizes. After sending off branches to the involucre, the remainder form a ring which branches *upwards* and terminates with small clusters of cords at the surface of the general receptacle (1, *vertical section*). These are for the florets. A transverse section below the base of the florets shows them to be already marked out by a slight differentiation of the ground-tissue (2). The groups of cords first separate into three (3), then into six (4), of which the three outer belong to the stamens and margins of the petal-lobes, the three inner to the carpels; *i. e.* two of them form dorsal cords, while the third and central one is the marginal (5), the ovary being already differentiated from the receptacular tube, as indicated by the

circle in figure 5 *. The five required for the tube and margins of the petal-lobes (as the midribs are wanting) are formed by chorisis of two of the three outer ones (5, 6, 7, *summit of ovary*).

In the male flower there are only the two dorsal carpellary cords (8), or at most occasionally three are present (9); and it may be remembered that three stigmas are also sometimes developed in the *Compositæ*, thereby indicating a tendency to a reversion to the theoretically ancestral number, five. These two dorsal cords on reaching the top of the ovary branch right and left, horizontally and then give off five cords in a vertical direction (10), at equal distances from one another, in order to supply the stamens. Figure 10 and figure 11 represent a vertical and horizontal view, respectively, and show the distribution of the cords.

XXXVII. HYPOCHŒRIS RADICATA.—In the flower of this plant the five staminal cords (*st.*) run down to the base of the ovary although united to the two dorsal cords, in the way shown in the figure, which will also explain how the cords have horizontal connections.

XXXVIII. ARTEMISIA VULGARIS.—In a disk-floret of this plant there are five cords running up the wall as in the last described plant; but on arriving at the summit of the ovary, two only branch to supply the style with two cords; while a complete horizontal zone connects all the cords together, indicated in the figure by a horizontal line.

The corolla of a ray-floret, which is very rudimentary, contains no cords at all. Two cords only arise from the base of the ovary, and these pass but a short way up the style.

The above described variations in the details of different genera of the *Compositæ* are interesting in showing the resources Nature has wherewith to supply the staminal and dorsal cords. It may be noticed that the remarkable way in which the staminal cords are supplied in the male *Calendula* and in *Hypochœris*, &c. finds a parallel in the *Campanulaceæ*, from which *Compositæ* have probably been derived. Thus in *Campanula Medium* the sepaline,

* This quasi-separation of the ovary from the receptacular tube is visible in other genera, as in *Alstrœmeria* (noticed by Ph. van Tieghem), &c., and clearly discountenances the idea of Sachs and others that all below the summit of an inferior ovary is axial.

staminal, half a petaline, and a dorsal carpellary cord, all arise from one and the same common stem *.

XXI. CAMPANULACEÆ (Pl. XXIX.).—XXXIX. JASIONE MONTANA.—The pedicel contains about ten cords (1). These multiply and send off as many as there are bracts to the small involucre (2). Branches come up to the surface of the general receptacle, as in *Compositæ*, for the florets (3). Each floret has five sepaline and two dorsal-carpellary derived from them. The five sepaline, on reaching the top of the ovary, send off horizontal branches, which form a complete ring around the base of the lobes (6). The same feature occurs in *Campanula rotundifolia*: from the middle point, where the two adjacent branches meet, the petaline cord issues (4, 6, *p.*); so that the petals are supplied with their median cords, exactly in the same way as the stipules of *Galium* are with their midribs. Figure 5 shows a dorsal carpellary cord (*d.c.*) springing from a sepaline (*s.*).

XXII. ERICACEÆ (Pl. XXIX.).—XL. ERICA CINEREA has a complete ring of cords in the pedicel (1). This sends off two pairs of cords for the sepals (2, 3). The number supplied to the corolla varies from eight to ten or twelve by the branching of one or more (4, 5). Eight are given off to the stamens, four of which stand in front of and four alternate with the petal-lobes (6, *st.*). Then follows the eight-lobed disk (D) formed from a swelling at the base of the pistil. Eight large cords alternate with the stamens (6). These tend to coalesce (7), and re-form into four large and four smaller cords (8). The latter soon pass outwards below the ovary-cells (*ov.*) †, and come up as dorsal carpellary (9, *d.c.*). The others are placentary (9, *pl.*). Ph. van Tieghem lays stress on the fact that these latter are oriented inwards, and therefore are axial. Since, however, the dorsal cords are already provided, it is clear that the group of eight is (8) *potentially* carpellary, though the ovary-cell are still wanting †. The point, therefore, where the axis ceases to exist is between the levels represented by figures 7 and 8; that is, immediately above the insertion of the stamens, and no part of the axis enters the

* A further description of the distribution of the cords of this species will be found in 'The Origin of Floral Structures,' pp. 43 and 71. See also Ph. van Tieghem's work, *l. c.* p. 73, pl. xii. figs. 67–73.

† The position of the future ovary-cells is indicated by four dotted rings (8, *ov.*).

pistil. The presence of the dorsal cords, as in Ivy, I take to be a positive indication of an already differentiated state of carpels, whether the placental cords have their tracheæ oriented inwards, or scattered over the phloëm, or accurately centered in it. In this order the carpels are superposed to the petals.

XLI. AZALEA INDICA.—A pedicel contains a complete ring, as in *Erica* (1). This sends off five branches simultaneously for the sepals (2), and then five for the petals (3). These divide into three each, which enter each petal (4, *p.*). Ten cords are then formed for the stamens, which thus show their freedom from the corolla, while recognizable as "traces" in the receptacle (3, 4). The remaining now form five placental cords with their tracheæ oriented *as if axial* (5); but as the dorsal carpellary cords are now situated behind the bases of the ovary-cells, the same reasoning applies in this case as in that of *Erica*, Ivy, &c In figure 6, the five placental cords have become double in number to supply the two rows of ovules in each ovary-cell.

XXIII. SCROPHULARINEÆ (Pl. XXX.).—XLII. DIGITALIS PURPUREA has a somewhat oval and compact cylinder in the pedicel (1). This sends off ten branches for the polysepalous calyx (2). Some of these again branch on entering the sepals (3). The corolla is provided with five cords (4, *p.*). The remaining ones close up and form a quadrangular prism (4, *ant.*, anterior, *pos.*, posterior side), the four corners supplying the stamens (4 and 5, *st.*); the fifth and posterior staminal cord being altogether wanting (indicated by *). As soon as the four staminal cords are gone, the rest form two arcs on the posterior and anterior sides (5). These now send off a large number of small cords which pass up the walls of the ovary-cells (6 and 7). The remainder close up and form two large placentary arcs of cords (7). Figure 8 represents a vertical diagram.

XLIII. PENSTEMON.—This begins as in *Digitalis* (XLII. 1, 2, 3). The fifth stamen is present, and therefore has a definite cord (1, *st*). The pistil has only two dorsal, and four placentary cords (1–4). Figure 2 is a section at the base of the corolla, showing the position of the petaline (*p.*) and staminal (*st.*) cords.

XXIV. LABIATÆ (Pl. XXX.).—XLIV. LAMIUM ALBUM supplies ten cords to the sepals (1, 2, 3). These rapidly multiply in such a way that the ten prominent ribs in the calyx-tube

become connected by a sclerenchymatous ring or cylinder, very loosely connected with lax mesophyll or merenchyma to the two epidermides. This ring consists of two or three layers of cells only. After supplying the corolla (3, *p*) the central cylinder becomes pentagonal (3), the posterior lobe representing the lost stamen. The remainder now forms six distinct cords, two being dorsal carpellary, and four placentary (4). The latter coalesce and form arcs with their convex sides towards the centre (5). As soon as the four cavities are visible, transverse arcs of cords are discovered connecting each pair of marginal or placental cords with their proper dorsal cord (the inner broken circle in fig. 6). From these are given off others at right angles, in connection with an outer circle of cords. This latter ring lies near the base of the disk, and it gives off vertical branches running upwards towards the lobed margin of the disk (7). Hence the disk is supplied with cords quite unlike the vast majority of honey-secreting glandular structures; and the formation is similar both to the origin of the cords in the corolla of *Jasione*, of the stamens of *Hypochœris*, and of stipules generally.

XLV. STACHYS PALUSTRIS and S. SYLVATICA differ from the preceding in supplying the corolla, stamens, and carpels simultaneously (1). In this section the ten cords for the sepals are visible on the circumference (1, *s.*), and the five petaline (*p.*), four staminal (*st.*), two dorsal cords (*d.c.*), and two placental (*pl.*) are all visible at once. The last-named soon separate into four distinct batches of tracheæ. Figure 3 shows the first appearance of the ovary-cells surrounded by the thick disk (D), which is supplied with cords as in *Lamium*. A vertical section (2) shows plainly how these arise, pass into the deeper part of the disk, then contract again and pass upwards into the ovary; so that the plexus seen in the gland in a transverse section is simply due to an expansion of the dorsal cords or similar branches from the marginal cords (*Lamium*, XLIV. 6, 7).

XLVI. BALLOTA NIGRA.—The pedicel supplies ten cords to the sepals (1, *s.*) and five for the petals of the corolla (1, *p.*); but instead of then giving off the staminal cords before the carpellary, these two whorls are supplied simultaneously; so that a cross section reveals two isolated cords (*d.c.*) forming the posterior and anterior dorsal cords, with two slightly crescent-shaped massive cords (2); and it is *these* which supply the four stamens as well as the marginal or placentary cords.

XXV. BORAGINEÆ (Pl. XXX.).—XLVII. SYMPHYTUM OFFICINALE.—The pedicel contains five larger cords situated at the angles of a pentagon, with one to three smaller ones intermediate between them (1). These five are for the sepals. The others increase (2) and coalesce till they form a more or less complete pentagon alternating in position with the previous one, the cords at the angles supplying the petals. These being given off, another pentagon supplies the stamens in a similar way (3). The remainder of the pentagon now becomes roughly four-sided (4). At this stage, two clusters of very large tracheids (*tr.*), resembling compound crystals or "macles," appear in the central parenchyma (4 and 6), and though originating freely, soon send off branches to unite with the now completed quadrangular zone (5, 7, 8). This latter now forms four groups of cords, each of which sends off a number of branches *below* the ovary-cell (8), which then rise up the dorsal side of it (9), partly nourishing the disk (10, D), which is formed at the base of the ovary-cells.

Each of the two star-like clusters of tracheids sends off a cord into the style (11).

The *Boragineæ* and *Papaveraceæ* (Pl. XXIII., v. 7 and 7 *a*) are the only two orders known to me in which tracheids are originated from merenchyma in the parenchyma totally independently of the cords of the axis.

XLVIII. ECHIUM CALYCINUM.—The pedicel has ten horseshoe-shaped cords (1). Five of them supply three-branched cords to the sepals (2, *s.*), as well as, subsequently, five for the stamens. Five others appear for the petals (2, *p.*). At this period the "macle"-like tracheids (*tr.*) appear, but though feebly developed are not connected with other cords (as occurs also in *Anchusa*). Then appear four separate subtriangular groups for the ovaries; but having no connection with the isolated tracheids (3, *tr.*). The cords form a plexus below each ovary-cell (3), as in *Symphytum* (XLVII. 8); then, rising up, appear at first to be about five in number, behind each ovary-cell (4). Each of the cords at the four inner angles of the groups (3) give rise to two placental (4, *pl.c.*). Figure 5 is a section above the base of the ovary-cells. The five dorsal cords have now increased in number to seven.

XXVI. PRIMULACEÆ (Pl. XXXI.).—XLIX. PRIMULA VERIS. The peduncle below the umbel has a pentagon with five prominent cords at the angles (1). These coalesce and then form as

many "points" as there are pedicels in the umbel (2). Each becomes rounded and throws off an arc of cords for the bract (3). The remainder form a series of arcs (4). They finally separate as pedicels, each of which contains five cords by coalescence of the superfluous ones (5). The five cords of the pedicels rapidly increase by radial chorisis to ten and become confluent at the base of the calyx (6). They then send off five cords for the calyx and five for the corolla (7, 8). The latter subsequently supply the epipetalous and superposed stamens. Five other rudimentary cords superposed to the sepals represent the lost or arrested stamens (7, 8, *ar.st.*). The remaining cords form a ring with ten lobes. These become resolved into ten placental (9, *pl.c.*) cords and five dorsal (9, *d.*). Besides the five dorsal, five other small cords are thrown off to pass up the wall of the one-celled ovary (10); while the ten larger ones enter the base of the free-central placenta. The tracheæ are central within the phloëm, and not oriented as if axial *. They form a tolerably correct circle in the specimens examined; but in a Himalayan species the grouping was distinctly pentangular with five cords in front of the sepals. This clearly shows that the pistil is really composed of five carpels superposed to the sepals, and that the free-central placenta consists of ten margins fused together.

Figure 11 represents a case I have met with in which the carpels of *P. sinensis* were dissociated and more or less foliaceous with rudimentary ovules, not only along the margins but with several borne on a "heel-like" process, which extends towards the centre of the ovary. This countenances the view that the free-central placenta of the Primulaceæ is really carpellary, and not axial. Anatomy, as shown above, clearly bears this out †.

With regard to the stamens being superposed to the petals, this is, of course, due to the arrest of the sepaline whorl. *Rhamnus* resembles *Primula* in having all the staminal cords in union with the petaline, but they part company at an earlier period than is the case in *Primula*. The cords are in fact distinct in the axis; whereas in *Primula* they do not become separate until a certain height is reached in the tube of the corolla. *Rhamnus*, however, differs from *Primula* in that no trace of the cords belonging to the sepaline stamens is discoverable.

* Ph. van Tieghem, 'Recherches sur la Structure du Pistil,' p. 11, pl. ix. fig. 2, represents them as having the tracheæ on the inner side, *i. e.* as if axial. I did not find this to be the case.

† See 'Origin of Floral Structures,' p. 76.

XXVII. POLYGONACEÆ (Pl. XXXI.).—L. RHEUM UNDULATUM.—The pedicel contains three or four principal cords (1). These increase and assume a triangular shape (2). Finally, it becomes six-angled in order to supply the six sepals. Three sepaline cords give rise to three staminal; while six others arise in pairs, as shown in fig. 4. The remainder, three in number, formed from the three sepaline which have not given rise to stamens, supply the carpellary cords (4). These finally result as dorsal carpellary cords, one having supplied a cord for the ovule at the base of the ovary-cell.

XXVIII. ARISTOLOCHIACEÆ (Pl. XXXI.).—LI. ARISTOLOCHIA CLEMATITIS.—A section at the base of the flower shows six cords passing off for the perianth or calyx, leaving six behind with a small lacuna in the centre (1). These six cords run up to the top of the ovary, then pass up the gynandrous column and bifurcate at the level of the insertion of the anther (2, *anth.*), one branch passing off to each, the others continue up the style to the base of the stigmas (2, *stig.*).

It has been thought that the styles and stigmas of the carpels are abortive in this genus; and that the now thickened connective of the anthers, coherent laterally into a tube and covered above with stigmatic papillæ, play the part of styles and stigmas *. This idea is not borne out by a study of the anatomy, which seems to show clearly that it is only a case where a cord does not become differentiated into a staminal and dorsal carpellary until the level of the anthers is reached. The stigmas are therefore truly carpellary, as is apparently always the case in other flowers. Moreover, they are free from the filaments to a much greater degree in *Asarum*.

XXIX. EUPHORBIACEÆ (Pl. XXXI).—LII. EUPHORBIA HELIOSCOPIA.—This has about ten cords in the peduncle below a three-flowered cyme (1). This at first forms a complete ring, and then throws off six cords, three on opposite sides (2); while small circles appear between the central one and the two groups of threes destined for the bracts (3). Thus three pedicels are formed. In the case where there are four flowers, one central and three circumferential, three cords travel outwards at each

* See 'Origin of Floral Structures,' p. 83, note.

corner of the triangle for each bract (3*). The three pairs of cords remaining are destined for the three pedicels (3*, *ped.*). These then appear as in (4). The three circular cords in the middle are destined for the central pedicel (3*, *c.ped.*).

Following out the course of the cords in one of the pedicels, the ring throws off five cords for the involucral cup (4, *inv.*), retaining a central ring by closing up. The former cords break up into clusters (5), each of which supplies a stamen with its cord. The stamen sooner or later frees itself from the common tissue of the involucre (7); so that vertical sections show how the staminal branches arise by chorisis in any direction (8, 9). Although the circular tissue of the stamen has an articulation (10, *art.*), the cord itself runs uninterruptedly through it up to the anther.

The central ring which supplies the pistil forms three distinct cords, each of which divides into a triple cluster (11): one, the middle cord, forming the dorsal carpellary (*d.*), the others, the marginal or placentary (*pl.*). Although the latter are somewhat oriented as if axial (12), that is with the tracheæ facing the medulla, yet the presence of the dorsal cord, with the base of the ovary-cell visible, proves that they should be regarded as marginal and placentary or foliar appendages, and are not axial in character.

Fig. 6 represents a so-called bract from the base of the involucral cup. It resembles rather a fern-scale or a paleaceous pappus of a Composite, as of *Galinsoga*; for it possesses no cords whatever.

LIII. BUXUS SEMPERVIRENS.—The female flower has a triangular arrangement of cords below the pistil (1), as in *Rheum* (L. 2). The corners send off the dorsal cords (*d.*), while the rest form three cords with the tracheæ facing the medulla (3), just as in *Euphorbia* (LII. 12). The cavities now appear (4), and the tracheæ quickly lose their "axial" orientation and become central (5, 6).

The pedicel of the male flower has a complete ring. This throws off two pairs of cords successively for the four sepals (7 & 8, *s.*), and for the stamens (9, *st.*) superposed to them; the remaining cords now pass upwards for a short distance, and, branching, terminate in fine points at the base of a quadrangular fleshy disk (D), which occupies the middle of the flower (9).

XXX. SALICACEÆ (Pl. XXXI.)—LIV. SALIX CAPREA.—In the flower of the female tree, after the branch has supplied the bract with its cord, the adjacent cords close up and pass up the pedicel of the pistil (1, *pi.*). The conical gland (G) is entirely without cords, as is normally the case with nectariferous organs.

In the male tree the cord which supplies the bract forms three branches (2 *b* and 3), and at the same time throws off two branches, one for each stamen (2, *st.*). The gland (G), as in the female, has none.

LV. POPULUS NIGRA.—In the male flower of the Poplar the cord which supplies the calyx (*ca.*) branches in a fan-like manner throughout it, and then sends up a cord for each of the stamens (*st.*).

XXXI. ORCHIDACEÆ (Pl. XXXII.).—LVI. OPHRYS APIFERA.—The pedicel contains six cords. A slight projection on one side indicates the site of the future labellum (1). At the base of the ovary it becomes more pronounced (2). A section across the placentas gives the form shown in (3)*. At the summit of the ovary the cords (still six in number) begin to show signs of multiplying (4). Each cord then divides into two, giving twelve in all (5). Fig. 6 shows how they become finally distributed, as follows:—The labellum (*lab.*) receives two cords (*st.*) from the lateral sepaline cords (3). These presumably ought to have supplied two of the stamens, which are, of course, absent. On the lower side, the two lateral petaline (*p.*) supply the anterior sepal with two, theoretically, staminal cords (*st.*). The staminal cord derived from that of the labellum is entirely wanting. On the other side, the single anterior sepaline (3) supplies the cord for the single stamen which is present.

It may be noticed that in Textbooks and Floras the ovary of *Ophrys* is sometimes described as twisted, as in *Orchis*. This is an error. The flower is merely bent over to the opposite side of the stem, thereby causing the labellum to take the lowermost position. In *Orchis* the ovary is twisted. This produces the same effect; but now the labellum stands directly over the bract.

* The position of the labellum is *uppermost* in all the figures, except number 3.

XXXII. AMARYLLIDACEÆ (Pl. XXXII.).—LVII. NARCISSUS TAZETTA illustrates the way pedicels are formed from a peduncle when the cords do not form a compact ring, as is generally the case in Exogens. The peduncle of this Narcissus is oval, and has an oval arrangement of cords somewhat wide apart (1). These branch on reaching the node in a confused manner (2), producing an ill-defined mass, as seen in a cross section. A little higher up this becomes broken up into irregular groups isolated in the parenchymatous tissue (3). The first few clearly differentiated belong to the sheathing-bract on the circumference (4); all the rest now become isolated as separate cords, usually in groups of five or more, and marked out in readiness for separation into pedicels (5). This is soon done by the development of epidermides between them, and variously angled pedicels result (6). They become triangular, and the cords are grouped into three larger ones at the angles and pairs of smaller ones between them (7). On approaching the base of the ovary, they multiply and form a dense triangular prism (8). This throws off three at the back of each ovary-cell as dorsal cords (9); three are intermediate and the rest form a broken circle in the middle (9). Twelve cords thus pass up the circumference, the central ring forming three placentary cords. Near the top of the ovary the axile mass contracts, while the septa bulge out and show the placentary cords, now arranged in two rows with the so-called "septal gland" between them. This is simply a place where the two epidermides of the coherent carpellary walls are differentiated and incoherent (10 and 10*).

LVIII. GALANTHUS NIVALIS (*fl. pl.*).—Ph. van Tieghem has described the anatomy of the single form, the pedicel being much the same as in the double. The number of cords vary from about six to eight (1, 2, 3). They increase to twelve, and then pass up the inferior ovary. In the double Snowdrop the cords form a massive ring (4). This divides into two concentric circles, the outer being sepaline and the inner petaline (5). These now branch repeatedly, and give rise to the immense number of cords supplying the numerous sepals and petals (6). There is often no trace of an ovary; hence the globular termination of the peduncle is wholly axial in nature, and is required for the multiplication of the petaline cords by repeated chorisis which takes place in various ways (7).

XXXIII. IRIDACEÆ (Pl. XXXII.).—LIX. CROCUS.—In this plant the pedicels are so closely adpressed within the sheathing-bracts, that they assume very various shapes (1–3). They contain an irregular distribution of larger and smaller cords. These ultimately coalesce into three (4), and then divide again to form six regularly distributed cords (5). As soon as the ovary-cells appear, six cords are discovered on the circumference and six, somewhat elongated, in the middle (6). These become finally more circular in outline (7). The sepaline cord (*s.*) behind the ovarian wall now gives rise to the dorsal carpellary cord (7, *d.*) by tangential chorisis. At a level where the septa are distinct, the sepaline (8, *s.*) has now given rise to the staminal (*st.*) by tangential chorisis; and the petaline (*p.*) by radial chorisis to two others (8).

LX. GLADIOLUS.—The flower of this plant shows a very symmetrical series of cords in the receptacular tube. In the centre is a large number of isolated cords (1) as soon as the ovary-cells are well formed. These will form the marginal or placentary cords. Alternating with each cell is a large cord, and behind it a threefold cord, of which the median one will form the dorsal cord, and the other two a sepaline and staminal. Higher up the central clusters of isolated cords form three irregular masses more or less fused together (2); but as soon as the three margins are visible, they become isolated, and a mass belongs to each triangular termination of a septum.

Higher up each divides into two cords (3, *pl.*), while a "septal gland" (3, *s. gl.*) appears between them; *i. e.* a portion of the two epidermides are differentiated and separate. While this is proceeding, the circumferential cords are dividing up in various ways to supply cords for the six leaves of the perianth and the three stamens (4). The style is shown in the central cavity.

XXXIV. LILIACEÆ (Pl. XXXII.)—LXI. ASPHODELUS RAMOSUS.—The stem below a flower contains two circles of cords. A slight protuberance on one side indicates where a bract will be formed. A single cord is isolated for this, and a small circle is formed below it (2). Of this circle, one cord is given off for a second bract (3, 4). The remaining three now belong to the pedicel. The pedicel is somewhat tri-lobed in section (6, 7). The three cords now multiply by chorisis (8, 9), forming ultimately

six regularly arranged, with a central circle within them (10). The cords at the angles are the first to divide (11). Then the others divide until the complete number is made for all the organs, and, lastly, the septal glands appear (12, *s.gl.*).

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with references to the pages where the details are described.

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G. H. ad nat. del. et lith.

West, Newman imp.

I. CLEMATIS. II. ANEMONE. III. RANUNCULUS. IV. ERANTHIS. V. PAPAVER.
VI. ECHSCHOLTZIA.

G. H. ad nat. del. et lith. West, Newman imp.

VII. CHEIRANTHUS. VIII. VIOLA. IX. RESEDA. X. DIANTHUS.

G. H. ad nat. del et lith. West, Newman imp.

XI. SILENE. XII. LYCHNIS. XIII. MALVA.

G.H. ad nat. del et lith. West, Newman imp.

XIV HYPERICUM. XV. GERANIUM. XVI. ERODIUM. XVII PELARGONIUM.

G.H. ad nat. del. et lith.

West, Newman imp.

XVIII. TROPÆOLUM. XIX. CYTISUS. XX. CERCIS. XXI. LOTUS. XXII. PISUM. XXIII. CERATONIA. XXIV. PYRUS.

G.H. ad nat. del. et lith. West, Newman imp.

XXV. RIBES. XXVI. ESCALLONIA. XXVII. SEDUM. XXVIII. FUCHSIA. XXIX. ANGELICA. XXX. DAUCUS. XXXI. HEDERA. XXXII. LONICERA.

G.H. ad nat. del. et lith. West, Newman imp.

XXXIII. LEYCESTERIA. XXXIV. VALERIANA. XXXV. SCABIOSA. XXXVI. CALENDULA.
XXXVII. HYPOCHÆRIS. XXXVIII. ARTEMISIA. XXXIX. JASIONE. XL. ERICA. XLI. AZALEA.

G.H. ad nat. del. et lith.

West, Newman imp.

XLII. DIGITALIS. XLIII. PENSTEMON. XLIV. LAMIUM. XLV. STACHYS.

XLVI. BALLOTA. XLVII. SYMPHYTUM. XLVIII. ECHIUM

G.H. ad nat. del. et lith.   West, Newman imp.

XLIX. PRIMULA. L. RHEUM. LI. ARISTOLOCHIA. LII. EUPHORBIA
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G.H. ad nat. del. et lith.		West, Newman imp.

LVI. OPHRYS. LVII. NARCISSUS. LVIII. GALANTHUS. LIX. CROCUS.
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C. Berjeau lith. West, Newman, imp.

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PLATE XXXI.

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PLATE XXXII.

LVI. *Ophrys apifera* (p. 193). LVII. *Narcissus Tazetta* (p. 194). LVIII. *Galanthus nivalis* (p. 194). LIX. *Crocus*, sp. (p. 195). LX. *Gladiolus*, sp. (p. 195). LXI. *Asphodelus ramosus* (p. 195).

ERRATUM.

Pl. XXIX. *for* "Hypochæris" *read* Hypochœris.

On the Production of Seed in certain Varieties of the Common Sugar-cane (*Saccharum Officinarum*, L.). By D. MORRIS, M.A., F.L.S., Assistant Director, Royal Gardens, Kew.

[Read 6th March, 1890.]

(PLATE XXXIII.)

THE Common Sugar-cane (*Saccharum Officinarum*, L.), as a cultivated plant, is known throughout the tropical and subtropical regions of both hemispheres. It is supposed to have originated in some portion of Southern Asia; but where, is not known. Roxburgh, Wallich, Royle, Aitchison, and other Anglo-Indian botanists saw no really wild plants in Hindustan or neighbouring countries. Rumphius, who carefully describes the cultivation of the sugar-cane in the Dutch Colonies, says nothing about the home of the species. Miquel, Hasskarl, and Blanco mention no wild specimens in Sumatra, Java, or the Philippines. Crawford expressly sought to find the wild sugar-cane in the Indian Archipelago, but failed to do so. Bentham, at a comparatively recent date and after an exhaustive survey of material from all

parts of the world, says "we have no authentic record of any really wild station for the common sugar-cane" *.

Another point connected with the life-history of the sugar-cane which has occupied attention is,—whether the sugar-cane, owing to the fact that it has been propagated for so many centuries by cuttings, or slips, has not, in common with other plants, such as the banana, plantain, and bread-fruit, lost the power of producing mature seed. A very general opinion exists at the present time, and indeed has existed for nearly a hundred years, that the sugar-cane does not produce seed. Hughes †, in 1750, speaking of the sugar-canes at Barbados states, "the glumes of their pannicles contains a whitish dust or seed, yet these being sowed, never vegetate."

Rumphius ‡ does not expressly state that the sugar does not flower and seed, but remarks, "Flores semenque nunquam profert nisi per aliquot annos steterit in loco quodam saxoso."

Macfadyen §, in regard to Jamaica, says that "it is a peculiarity of the (sugar) cane in this climate, that it refuses to perfect its seed. Ever since its cultivation in this island it has been raised from cuttings of the joints."

Sir William Hooker ||, citing Roxburgh, states that "notwithstanding his long residence in the country of the Ganges (he) never saw the seed of the sugar-cane." And, lastly, we have Hackel, the recent Monographer of the *Andropogoneæ* in de Candolle's 'Monographiæ Phanerogamarum,' under *Saccharum officinarum*, L., p. 112, adding "Caryopsis nemo adhuc videsse videtur."

De Candolle is therefore no doubt correct in the statement that no one has hitherto described or drawn the seed of the sugar-cane ¶.

The flower of the sugar-cane, on the contrary, has often been figured and described. One of the earliest figures is given by Tussac ('Flora Antillarum,' 1808–1827), copied by Hayne ('Arzneykunde,' ix. tt. 30, 31). These exhibit the character of the stems and general habit, but the analysis of the flower is poor.

* Flora Hong-Kong, p. 420.

† Hughes, Barbados (1750), p. 244.

‡ Rumphius, Amboin. vol. v. p. 186.

§ Hooker's Bot. Misc. vol. i. p. 99. || Ibid.

¶ Origin of Cultivated Plants (1882), p. 157.

Later, there is given a good drawing of the plant and flower, in Hooker's Bot. Misc. i. p. 101; to this is added a full account of the sugar-cane and its cultivation in Jamaica, by Macfadyen. An excellent drawing, with a full analysis of the flower and pistil, is given by Schacht ('Madeira und Teneriffe,' tab. 1). This I regard as the most satisfactory representation of the floral structure of the sugar-cane. The description given by Bentley and Trimen ('Medicinal Plants,' tab. 298) is excellent, but the analysis of the flower is by no means good.

In all these, no attempt has been made to describe the seed. It is probable, therefore, that so far no ripe seed had come under the notice of the numerous botanists who had described the plant and flowers.

During the last two years, owing to very intelligent experiments carried on at the Botanical Station at Barbados, Professor Harrison and Mr. Bovell have shown very conclusively that certain varieties of the common sugar-cane still produce mature fruit. The first statement on the subject by Professor Harrison has already been published *. It is only necessary to mention here, that for many years self-sown seedlings of sugar-cane appear to have been observed at Barbados and elsewhere. Some of these natural seedlings have been successfully raised and established. Owing, however, to the very few fertile fruits produced in each panicle—possibly not more than one in every three or four thousand spikelets—and owing also to their very small size, it is very difficult indeed to observe them †. The experiments at Barbados, confirmed by observations at Trinidad, Demerara, and latterly at Kew, have now very clearly proved that the varieties of sugar-cane known as "Purple Transparent" and "White Transparent" periodically produce seed at Barbados; and that the Bourbon cane, known also as the "Otaheite cane," does so very sparingly. From seed of the former, received from Barbados, sugar-cane plants have been successfully grown at Kew, and observations have been made which are embodied in this note.

Although there are numerous varieties of the common sugar-cane, only a few are widely cultivated in sugar-producing countries. These being propagated by cuttings or shoots, retain

* Kew Bulletin, 1888, p. 294.

† On the economical value of the fact that the sugar-cane does produce seed see Kew Bulletin, 1889, p. 242.

all the character and peculiarities of the parent plant. In the West Indies the chief variety cultivated is the Bourbon or Otaheite cane. This is also widely cultivated in Mauritius, and under other names it is the favourite variety in the East Indies and Polynesia.

At the Jamaica Botanic Gardens in 1884 there were in all sixty varieties of sugar-canes under experimental cultivation, and these were readily distinguished by the foliage, by size, colour and character of stem, and by general habit *.

The flowering panicle (without the hollow stem) varies from 2 to 3 feet †. The numerous spikelets are arranged in pairs, one being sessile, and the other stalked, surrounded by a dense ring of long, white, straight, spreading hairs, arising immediately below, and coming away with the spikelets. All the spikelets examined were one-flowered and hermaphrodite. The single purple pale enclosed in the upper glume is present or sometimes reduced to a film. The red lodicules vary from two to three, and are either truncate or 2–3-lobed. The yellow stamens were fully developed, and in a few instances the pistil was rudimentary. The upper part of the bifid purple stigma is large and densely plumose. The caryopsis, where present, is free and enclosed within the pale and glumes; it is about $\frac{1}{16}$ inch long, $\frac{1}{48}$ inch wide, elliptical-oblong, smooth or finely striated, flesh-coloured, and surmounted by the persistent bases of the style. The albumen is nearly white, subtransparent. The embryo is lateral, one-sixth the length of the caryopsis. In germination, the plumule and radicle emerge without the cotyledon (Plate XXXIII. fig. 5).

[NOTE.—Since this paper was read I have received, through the kindness of Dr. van Eeden, Director of the Colonial Museum at Haarlem, a copy of "Mededeelingen van het Proefstation Midden-Java te Semarang, over suikerriet uit zaad door Dr. Franz Benecke, met 23 figuren." Semarang, G. C. T. van Dorp & Co., 1889. In this a very complete account is given of observations made in Java, which have undoubtedly to a great extent anticipated those made at Barbados and described above.

* Jam. Botanical Depart. Report, 1884, pp. 31–34.

† According to Munro (Journ. Linn. Soc. vol. vi. p. 36), the specimens marked by Linnæus himself *Saccharum Officinarum* are not the true sugar-cane but *Erianthus japonicus*, Beauv.

Dr. Benecke shows clearly that the occurrence of fruit in sugar-cane had been observed by him during the years 1887 to 1889, and he is probably the first to have published (in 1889) a description with drawings of the fruit and the mode of germination. Those interested in the subject are referred to Dr. Benecke's pamphlet. In the meantime the above short summary will emphasize the fact and bring to the notice of botanists generally the possibility now of multiplying the sugar-cane by seminal reproduction.—D. M.]

DESCRIPTION OF PLATE XXXIII.

Fig. 1. Portions of flowering panicle of sugar-cane, showing arrangement of spikelets.

Fig. 2. A single spikelet enlarged (after Hooker). *a*=upper glume. *b*=pale. *c*=lower glume. *d*=anthers. *e*=lodicules. *f*=ovary. *g*=stigma.

Fig. 3. Ovary and stigma, ×10.

Fig. 4. Caryopsis removed from glumes ×10, with longitudinal and cross sections.

Fig. 5. Caryopsis, showing first stage of germination.

Fig. 6. Later stage of germination.

Figs. 7, 8, and 9. Germination observed when the caryopsis is still enclosed in its glumes.

Fig. 10. A seedling sugar-cane, natural size, three months old.

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VOL. XXVI. Nos. 173–175.

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For issues of Zoology see Notice on back of the Zoological Journals.

The Meetings of the present Session, which began on November 6th, until further notice will be as under :—

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FEB.	" "	5th.

The Chair will be taken at 8 P.M.

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THE JOURNAL

OF

THE LINNEAN SOCIETY.

VOL. XXVIII. **BOTANY.** No. 193.

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NOTE.—The Charter and Bye-Laws of the Society, as amended to the 19th March, 1891, may be had on application.

Dr. Benecke shows clearly that the occurrence of fruit in sugar-cane had been observed by him during the years 1887 to 1889, and he is probably the first to have published (in 1889) a description with drawings of the fruit and the mode of germination. Those interested in the subject are referred to Dr. Benecke's pamphlet. In the meantime the above short summary will emphasize the fact and bring to the notice of botanists generally the possibility now of multiplying the sugar-cane by seminal reproduction.—D. M.]

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On the Development of the Sporangia in *Rhodochorton Rothii*, Näg., and *R. floridulum*, Näg.; and on a new Species of that Genus. By R. J. Harvey Gibson, M.A., F.L.S., F.R.S.E., Lecturer on Botany in University College, Liverpool.

[Read 5th June, 1890.]

(Plate XXXIV.)

The following observations were made on material collected on rock-ledges in caves at Dinmor Point, Anglesea, and examined fresh in the Laboratory of the Liverpool Marine Biological station at Puffin Island.

The habit of *Rhodochorton Rothii* is described by Harvey

('Phycologia Britannica,' pl. cxx. B.) in the following words:—"Spreading over the surface of rocks, about half-tide level." *Conferva purpurea*, Dillw., which Harvey unites with *R. Rothii* under the name of *Callithamnion Rothii*, he describes as being found "on maritime rocks, within the influence of the spray, but beyond the reach of ordinary tides." I have collected specimens of *Rhodochorton Rothii* at all levels from extreme low water at a 20-foot tide to two or three feet above high-water mark, and found that the nearer the plant grows to low-water mark the larger, brighter, and more branched it becomes.

General accounts of this species are given by Kützing *, J. G. Agardh †, Hauck ‡, and Thuret §.

Rhodochorton Rothii occurs in the form of broad velvet-like expansions of a dull crimson colour, from 2 millim. to 1 centim. in thickness. The upright filaments arise from a densely interwoven creeping network of filaments, the cells of which are about as long as broad. The erect filaments are of uniform diameter throughout, the cells being about one and a half to two and a half times as long as they are broad. The branches arise alternately and at very acute angles with the main axis. The branching is very sparing, save near the apex.

The dense corymbose clusters of sporangia (tetrasporangia) are terminal or subterminal, and their position and mode of origin furnish a good diagnostic difference between this species and *R. floridulum*, Näg., and *R. chantransioides*, Reinke, where they arise secundly along the branches.

Their mode of development is as follows:—Copious terminal branching first of all takes place in the apical region of a vegetative filament, the secondary branches arising as buds from the penultimate cells of the primary branch. The sporangia arise usually on branches of the fourth order. Each sporangium is formed from a bud of the penultimate cell of a branch, the bud becoming separated from the parent cell by an oblique septum (Pl. XXXIV. fig. 11). The cell then loses its oblong cylindrical shape and becomes oval, the narrower end being next the parent cell. The contents segment transversely to the long axis, the two halves again dividing parallel with the long axis. The spores

* 'Species Algarum,' p. 640.

† 'Species, Genera, et Ordines Algarum,' ii. p. 17, iii. p. 13.

‡ 'Die Meeresalgen Deutschlands und Oesterreichs,' p. 68.

§ In Le Jolis' 'Liste des Algues marines des Cherbourg,' p. 111.

(tetraspores) are thus quadrants, not tetrahedra as, for example, in the genus *Polysiphonia*. The apical cell meantime increases in length and subdivides transversely into a new apical cell and a basal cell, from which latter a new sporangium arises in like manner. When the spores are mature the wall of the sporangium ruptures at the apex and the spores escape, the empty sporangium remaining attached. The parent cell then gives off another bud into the cavity of the empty sporangium (fig. 10). Usually, though not invariably, the second bud, after separation from the parent cell, divides transversely into an apical cell and a basal cell from which a new sporangium arises, the basal cell being sheathed by the torn wall of the first formed sporangium (fig. 10). Often, however, the second bud itself becomes the mother cell of a sporangium, and in such cases a series of sporangia may be so formed, the torn walls of preceding sporangia remaining as sheaths round the base of the sporangium of the time being (fig. 7). Other conditions still are to be met with. The bud may divide into a basal and apical cell, the sporangium being developed not from the basal cell but from the apical cell directly (fig. 6).

The spores when shed germinate into cell-rows sparingly branched. The sporangia begin to be formed from January onwards, so that by the end of March every filament bears at its apex a cluster of sporangia.

The method of innovation described as occurring in the development of the sporangia is only an extension of the mode of renewed growth of the vegetative filaments. Injury to a filament and removal of the apex is followed by apical growth of the next uninjured cell into the cavity of the ruptured cell (figs. 8, 9)

The sporangia of *R. floridulum*, Näg., show similar innovations to those described as occurring in *R. Rothii* (fig. 12). I have not met with *R. chantransioides*, Reinke, and am therefore unable to say whether the same phenomenon is exhibited by that species. Certainly Reinke's figures * do not indicate any basal sheaths such as I have described as occurring in *R. Rothii* and *R. floridulum*. I may add that these sheaths may also be observed in *R. membranaceum*, Maq.

Similar phenomena in the development of sporangia are known to occur in the Sphacelariaceæ and other groups.

* Atlas deutscher Meeresalgen, tab. 21.

RHODOCHORTON SEIRIOLANUM, sp. nov.

Diagnosis. Thallus filamentis rectis, eramosis, e strato cellularum surgentibus; tetrasporangia vel terminalibus vel secundis, vel utrisque; colore roseo.

Hab. On *Polysiphonia urceolata* at low water, Puffin Island, Anglesea.

On examining some old *Laminaria*-stems gathered at extreme low water (spring-tide) at Puffin Island (S. Seiriol's Isle), Anglesea, in March 1890, I found some epiphytic *Polysiphonia urceolata* covered with the minute species which I here describe. I submitted specimens to Mr. G. Murray, F.L.S., who believed it to be a new species. I sent specimens also to M. Bornet, who was kind enough to give me his opinion on the matter. I had considered it as a species of *Rhodochorton*, but M. Bornet pointed out to me that the discoid basal layer indicated affinity with *Chantransia*. Its general appearance and the presence of well developed and abundant tetraspores, however, clearly demonstrated an even closer relation to the genera *Rhodochorton* and *Callithamnion*. Indeed, M. Bornet suggested the possibility of its being near *Callithamnion humile*, Kütz., in systematic position. In that species, however, the apices of the upright filaments, at least in Kützing's figure, are branched, while in my plant the filaments are quite simple. In character it seems halfway between the genera *Rhodochorton* and *Chantransia*, but I insert it temporarily under the former and venture to give it the name of *Rh. seiriolanum*, after the island on whose shores I found it. Whether it may be left there, or form the type of a new genus, or whether, as suggested to me by Mr. Batters, the genus *Rhodochorton* must be divided into two subgenera, one with a discoid base, the other with creeping filaments, I leave for discussion in a paper on the revision of the genus *Rhodochorton* on which I am engaged.

I may add that I have found in the present species the same mode of innovation of sporangia I have described above for *R. Rothii*, *R. floridulum*, and *R. membranaceum*.

EXPLANATION OF PLATE XXXIV.

Figs. 1–5. *Rhodochorton seiriolanum*, n. sp.

Fig. 1. Part of a branch of *Polysiphonia urceolata* with *R. seiriolanum* epiphytic on it, × 55.

R.J.H.G. del.
C. Berjeau lith.
West, Newman imp.

FIGS. 1–5. RHODOCHORTON SEIRIOLANUM, *n. sp.*
FIGS. 6–11. R. ROTHII. FIG. 12. R. FLORIDULUM.

Fig. 2. The same, × 355, showing terminal and secund sporangia.
3. The basal cell-layer from which the upright filaments spring, × 355.
4. A filament showing innovation of the filament after the escape of the tetraspores from a terminal sporangium, × 450.
5. Terminal sporangium with tetraspores and innovation of a subterminal sporangium, × 450.

Figs. 6–11. *Rhodochorton Rothii*, Näg.
Fig. 12. *R. floridulum*, Näg.

All drawn with Zeiss's objective E, ocular 2, with drawn tube. The details of cell-structure are not indicated.

Figs. 6, 7, 10. Various stages in the development of sporangia formed by innovation. ×355.
Figs. 8, 9. Innovation in vegetative filaments. ×355.
Fig. 11. Development of sporangia from buds of subapical cells; in one case the spores have escaped and a second bud is developing in the cavity of the empty sporangium. ×355.
Fig. 12. Sporangium in course of formation by innovation in *R. floridulum*. ×355.

On the Development of the Cystocarps in *Callophyllis laciniata*, Kütz. By A. Lorrain Smith. (Communicated by D. H. Scott, M.A., Ph.D., F.L.S.)

[Read 5th June, 1890.]

(Plate XXXV.)

Callophyllis laciniata, on which the investigation recorded below was made, belongs to the family of the *Gigartinaceæ*, one of the Florideæ.

It has a flat isobilateral much-branched thallus. It is diœcious, and the fruiting-thallus bears a large number of cystocarps.

Harvey in his 'Phycologia Britannica,' vol. ii. plate 121, thus describes it under the name of *Rhodymenia laciniata* :—

"Frond thickish, subcartilaginous, opake, bright red, more or less palmate or flabelliform, cleft into numerous broad wedge-shaped segments, which are again divided in a subdichotomous manner; the apices obtuse, the margins, when in fructification, curled and fringed with minute cilia, in which the tubercles are imbedded."

These so-called "cilia" appear at first as slightly thickened irregular outgrowths towards the growing points of the thallus. They become larger, and consequently more crowded, as the fruits ripen.

A section through a mature cystocarp presents the appearance shown in Pl. XXXV. fig. 5. There is a broad pericarp enclosing a central mass of spores; the outer layers of the pericarp are of small, closely adhering cortical cells, the inner layers are of larger cells. Immediately surrounding the spores, we often find seemingly elongated much-crushed cells very full of contents. The spores themselves are arranged in larger or smaller groups, each occupying its own compartment, and mostly separated from the other groups by a broader or narrower wall of thallus-cells elongated and compressed like those that surround the whole mass.

The spores are irregularly round or oval; they vary in size and shape. They lie in loose groups, or sometimes in regular rows and chains of connected spores. Occasionally we find a little packet still surrounded by an outer cell-wall, showing that division is not yet quite completed.

The main axis of the thallus is a solid mass of apparently parenchymatous tissue. The medullary part consists of very large cells interwoven with smaller cells which have more abundant contents. The cortex is of radiating filaments of still smaller cells, more regular in size and closely packed together.

In the outgrowths destined to hold the cystocarps, we find the large medullary cells are smaller and richer in contents than the cells of the vegetative thallus; the interstitial cells seem to be more numerous; the cortex is thicker, forming a strong compact envelope for the future fruit. This thickened cortex is already present to some extent when the procarps first appear.

At a very early stage, various cells of the outer medullary tissue and inner cortex are differentiated from the rest, and become densely filled with protoplasm. Some of these cells, auxiliary cells we may call them, are large and irregularly shaped (Pl. XXXV. figs. 1 & 2). They continue to grow apparently at the expense of the surrounding tissue. Along with these are smaller cells exactly similar in contents.

These differentiated cells go to form the procarp, but I have failed to trace their relation to each other, whether they all

belong to the carpogonial branch, or whether some of them may not arise from other neighbouring branches.

The carpogone with its trichogyne is borne upon one of the smaller cells, which again lies alongside of a large auxiliary cell.

The trichogyne has often, though not always, the little coil near its base, so characteristic of *Polyides* and some other Florideæ. It forces its way between the cortical cells, and finally protrudes, sometimes to the extent of a third of its length.

At a later stage, presumably after fertilization, fusion takes place between the carpogone and the auxiliary cells.

At this stage the procarp is an irregularly-shaped mass of fused cells with projections on all sides. After staining with methyl-green, one of the procarps was shown to contain a considerable number of nuclei, the result evidently of the fusion of the different cells and of subsequent divisions of these nuclei.

The remains of the trichogyne can be traced in such procarps, but the basal portion of the carpogone can no longer be distinguished, having evidently become confluent with the next auxiliary cell.

Each cystocarp contains a varying number of these procarps; sometimes they are separated from each other by a mass of tissue, sometimes they are crowded together in immediate contact. They remain, however, separate and distinct; in no case was there any proof of the existence of fertilizing filaments, such as occur in *Polyides*, *Dudresnaya*, &c., nor is there any evidence that fusion takes place between the cells of different procarpial groups.

The procarp next divides up by walls parallel or at right angles to each other into a mass of large cells. These cells again divide by walls in all directions (fig. 4).

At this stage the primary and secondary divisions can be distinctly traced, and the whole procarp breaks up; there does not seem to be any sterile tissue left.

From the ultimate divisions we get the spores. These, as has been already mentioned, lie in groups, each of which is the product of a single procarp. The groups may be quite isolated and completely surrounded by the compressed thallus-tissue, or they may lie so closely together that several groups seem merged into one. This is easily intelligible, as at an early stage two or more procarps are often found in close contact.

The spores sometimes lie in the position left by the last divisions; more generally, in the ripe condition they are entirely free from each other.

Dehiscence takes place by an opening in the wall on the side of the cystocarp.

The conclusion, then, to which my investigation leads is, that the cystocarp of *Callophyllis laciniata* is a compound body, including the products of a number of procarps.

The investigation was carried on at the Normal School of Science [now the Royal College of Science], in the Laboratory of Dr. D. H. Scott, to whom I have been indebted for continual advice and assistance.

The material was collected and preserved at Plymouth during the summer of 1889 by Professor T. Johnson of Dublin, who kindly placed it at my disposal for investigation. I have also to thank him for much help and encouragement during the progress of my work.

EXPLANATION OF PLATE XXXV.

c=carpogone; *t*=trichogyne; *a*=auxiliary cell.

Fig. 1. Carpogone unfertilized with 2 auxiliary cells. ×444.

Fig. 2. Semi-superficial section of a young cystocarp, showing several procarps and trichogynes. ×170.

Fig. 3. One or more procarps after fusion, showing the nuclei. The remains of a trichogyne are still to be seen. ×444.

Fig. 4. Procarp, showing the primary and secondary division-stages towards the formation of spores. ×440.

Fig. 5. Section through an almost ripe cystocarp, showing the grouping of the spores. ×166.

A. L. Smith del.
R. Morgan lith.

West, Newman, imp.

CALLOPHYLLIS LACINIATA. *Kütz.*

On the Structure and Systematic Position of *Chantransia*; with a Description of a New Species. By George Murray and Ethel S. Barton.

[Read 5th June, 1890.]

(Plates XXXVI. & XXXVII.)

The genus *Chantransia* has been, since its establishment, one of the most interesting among Algæ, not only on account of its remarkable position as one of the so-called primitive types of Florideæ, but also from a supposed relationship ascribed to certain of its forms with *Batrachospermum* and *Lemanea*. The history of the genus is, in fact, an exceptionally stormy one; its systematic position has been the subject of argument, the generic characters have been emended and its validity as a genus has been challenged. It is happily unnecessary for us to penetrate farther into the history of these changes than the Thuretian conception of the genus. This author writing (1863) in 'Le Jolis, Algues Marines de Cherbourg,' p. 104, says:—

"The genus *Chantransia* has not been kept to the limits assigned to it by De Candolle; since it contained species belonging to *Lemanea*, *Batrachospermum*, *Cladophora*, and *Œdogonium* (Fl. Fr. ii. p. 49 *et seq.*). Fries re-established it later (1825) on a better basis, taking for its types *Conferva Hermanni* and *C. chalybeia* of Roth. These two plants, living in freshwater, bear a strong resemblance to certain minute marine species which form part of the *Callithamnion* of Lyngbye. Harvey long ago recognized this resemblance, which had compelled him in 1836 to re-unite the marine and freshwater species under the genus *Trentepohlia* (Mackay, Flor. Hibern.). More recently, however, this celebrated algologist has changed his opinion and replaced the marine species in *Callithamnion*. He has even described and figured for some of them veritable tetraspores (Phyc. Brit. tabb. 313, 314). The existence of such organs would justify the position which he assigns to these plants if it were well demonstrated. But I think that there is some error here resulting from the study of dried specimens. At least I have never been able to find tetraspores, and I trust implicitly on this point to the excellent observations of M. Areschoug (Phyc. Scand. marin. p. 115), confirmed recently

by M. Pringsheim (Beitr. zur Morphol. d. Meeres-Algen, p. 26). I have never seen in these plants anything but undivided spores, having a tendency more or less to group themselves on short lateral branches, in such a manner as to form in certain species small glomerules, sometimes replaced by clusters of antherids. That these glomerules or groups of spores represent the most simple state of conceptacular fructification of the other Florideæ, one can hardly doubt, especially when one compares them with organs of the same nature in other genera; &c."

Though Harvey was wrong as to the division of the spores into tetraspores, he was nevertheless right in his view of the morphological value of these bodies. They are commonly called monospores, and understood to be the homologues of the tetraspores of the other Florideæ. That Thuret, though right in his observation, was wrong in regarding them as equivalent to conceptacular fruits, was made abundantly clear by the description of the true cystocarps of *Chantransia corymbifera* by Bornet and Thuret, 'Notes Algologiques,' p. 16, tab. v. (1876). Before this, however, in 1873, M. Sirodot described the monospores, antherids, trichogynes, and cystocarps of a freshwater species, *Ch. investiens*, Lenorm. (Comptes Rendus, vol. lxxvi. pp. 1338–39). M. Sirodot, however, thought fit to remove this species from *Chantransia* and make it the type of a new genus, *Balbiania* (Ann. Sci. Nat. 1876, 6e sér. tom. ii. p. 146). Whether this distinction should now stand will be seen later. It is mentioned here now because the discovery of its sexual reproductive organs takes precedence of the case of *Ch. corymbifera.*

As the matter now stands, the position of the genus in the estimation of botanists is as follows:—In the sea there occur certain species typified by *Ch. corymbifera*, Thur., of which both the sexual reproductive system and the propagation by monospores have been described and figured by Bornet (*loc. cit.*). In fresh water there occur certain other species (excepting for the present *Ch. investiens*=*Balbiania investiens*, Sir.), which are regarded by M. Sirodot as non-sexual forms of *Batrachospermum*. His views on this subject are most fully expounded in his elaborate treatise, 'Les Batrachospermes,' Paris, 1884. According to him these "*Chantransia*-forms" are the sporophytes of *Batrachospermum*,—forms which do not attain a sexual reproduction unless in the shape of *Batrachospermum*—his own discovery of antherids and cystocarps in *Ch. investiens* having been swept from the track

of this theory by the removal of the species into *Balbiania* created for its reception.

It is well known that the carpospore of *Lemanea* on germinating puts forth a so-called protonemal filament on which the fertile axes are borne; and it has been asserted by Peter (Bot. Verein, München, 28 Feb. 1887) that the sexual *Lemanea fluviatilis* may develop from the heteromorphic branches of a *Chantransia*. Sirodot had also ('Les Batrachosperm.' p. 4) made a similar assertion as to the connexion of *Ch. violacea* and *Ch. amethystea* with *Lemanea*.

In the 'Annals of Botany' (vol. iv. no. xiv., May 1890) there is a paper by Prof. Atkinson on "The Lemaneaceæ of the United States," in which the so-called "*Chantransia*-forms" of *Lemanea* are described. According to this author also the "*Chantransia*-forms" in question do not produce monospores, but stand in the relation of a protoneme to *Lemanea*.

In addition to this there are a small number of species of *Chantransia* growing in fresh water and described in systematic books which have had no definite position or relation assigned to them.

Such, then, is the extraordinary position of this genus. The marine forms only are perhaps regarded as valid, but exist merely on sufferance. The freshwater forms are some of them sporophytes of one plant or protonemes of another, while a residuum remains unattached to anything at present in the limbo of systematic papers on freshwater Algæ.

The principal material of the present research was collected by Prof. Bower and Mr. Murray, in the beginning of last April, in the stream near Duntocher, running out of Loch Cochno on the Kilpatrick Hills, Dumbartonshire. The *Chantransia* was growing on *Lemanea fluviatilis* in minute tufts, rooting in the tissues of its host. On comparison with other species of *Chantransia*, notably with *Ch. violacea*, it was found to be new to science, and we have therefore described it below as *Chantransia Boweri* in honour of its finder. The separate filaments grow to about 1 millim. in length, and the branches, which are always given off at the upper end of the cells, are either opposite or alternate indefinitely. The branches and twigs end each in a long hyaline hair with a slightly rounded tip. The lower cells of a filament are 3–4 times, those occupying the middle portion 4–5 times as long as the diameter; while the cells at the tip diminish in length

to about twice the diameter. The cell-walls are thinner in the apical than in the basal cells. The filaments are attached to the *Lemanea* by means of non-septate and much-coiled rhizoids.

Sessile monospores are borne in great abundance on the branchlets generally opposite in twos, often in threes. Such clusters occur at the ends of the branches, sometimes with the terminal hyaline hair, sometimes without it. They are rather pyriform than oval in shape, and of a deeper colour owing to denser contents than the cells of the filaments. When the branches are in full-bearing, monospores terminate nearly every twig and the hyaline hairs are only rarely to be met with (Plate XXXVI. fig. 1).

We have not been able to observe the escape of these monospores, since the material was preserved in alcohol before the microscopic examination took place. They are, however, not simply detached, since after the escape there remain the empty spore-cases *in situ* (figs. 4 and 5). This spore-case or outer wall is apiculate and hyaline, while the inner one is darker in colour.

From the fact that traces of empty spore-cases sometimes appear round the base of monospores, it would appear that new outgrowths occur through these old spore-cases (figs. 4 and 5), as in the unilocular sporanges of *Cladostephus*. We must regard these monospores as produced in monosporanges (=spore-cases), the homologues of the tetrasporanges of other Florideæ *.

The above description represents the usual appearance of the plant as collected. Patient examination of it, however, was rewarded by other discoveries, viz. antherids, trichogynes, and cystocarps. The antherids (Pl. XXXVII. fig. 4) resemble, as will be seen by the figures, most closely those of *Ch. corymbifera*; they form dense clusters, and each pollinoid is about two-thirds the diameter of the adjacent filament in size. The cystocarps (Pl. XXXVII. figs. 2 and 3) form corymbose stalked clusters of carpospores which are in size about twice the diameter of the filaments which bear them. It will be seen from the illus-

* As further confirming this view, it may be added that, in the course of observations on a marine species, *Chantransia secundata*, we have observed its early stages of germination on *Cladophora rupestris*. The monospore first divides *into four*, and then so closely resembles a tetraspore that the acceptance of this view as to its homology becomes irresistible (Pl. XXXVII. fig. 5). This division then proceeds in the same plane, thus giving rise to the membranous base of *Chantransia*, from which the upright filaments arise.

trations that the development of the cystocarp also resembles *Ch. corymbifera*, the marine species, as described by Bornet. Owing to the scarcity of material in this condition, we were unable to investigate this process of development more fully. The trichogynes, so far as we have observed them, rather resemble the figure of *Ch. corymbifera* by Schmitz ("Unters. ü. d. Befrucht. d. Florid.," in the Sitzungsber. d. Berlin. Akad. 1883, plate v. figs. 2, 3, & 4) than those by Bornet. The observer is constantly misled by the appearance of clusters of monosporanges surrounding an emergent hyaline hair into the belief that he is witnessing a young cystocarp crowned by a trichogyne. Such clusters have a wonderful superficial resemblance to the young cystocarps of *Nemalion* for example, though in *Ch. Boweri* the greater size of the carpospores enables one to detect them at once when accompanied in the same field by monosporanges. Besides more essential differences, the carpospores are of course in denser clusters and greater numbers in each cluster.

The following diagnosis of the species sums up briefly its characters :—

Chantransia Boweri, n. sp.; cespite minuto, pallide violaceo; filis radiatim dispositis ·0085 mm. crassis, articulis quam diametro inferioribus 3–4plo, superioribus 4–5plo, supremis duplo longioribus, ramulis apicibus piliferis, oppositis interdum irregularibus; monosporangiis apiculatis, monosporis ovalibus aut subpyriformibus sessilibus, oppositis binis aut ternis; cystocarpiis et antheridiis corymbosis, pedicellatis.

Ad *Lemaneam fluviatilem* in rivulis prope Duntocher, montibus Kilpatrick, com. Dumbarton, Scotia; legerunt Bower et Murray, die dominica paschali April 1890.

The nearest species, *Ch. violacea*, which also grows on *Lemanea*, differs from it (1) in the absence of the long hyaline hair at the end of the branches, and (2) the different proportions of the joints, and (3) in the thicker cell-walls. These combine to give it a quite different appearance *.

* In examining species of *Chantransia* the student should be warned against the very deceptive appearance presented by the epiphytic species of *Dermocarpa* and the like. Not only in the case of *Chantransia violacea* in fresh water, but in *Chantransia secundata* in the sea, we have been temporarily misled several times by the extraordinarily close resemblance borne by clusters of *Dermocarpa* and its spores to both cystocarps and antherids. Minute and careful study and comparison alone enables one to avoid mistake in this matter.

The supposed relationship of "*Chantransia*-forms" with *Lemaneaceæ* has been mentioned already, and it now becomes necessary to examine this question more carefully in the light of the facts set forth. More especially is this the case, since *Ch. Boweri* and *Ch. violacea* grow on the thallus of *Lemanea.* In Prof. Atkinson's paper, p. 222, *Chantransia violacea* var. *Beardslei*, Wolle, is quoted under *Lemanea fucina*, Bory; and in a foot-note to this he says, "This is the *Chantransia*-form of *Lemanea* (*Sacheria*) *fucina*, Bory, var. *rigida*, which Wolle found 'as an undergrowth, intermingled with *Lemanea*, which was fringed with the parasitic *C. violacea*,' from Painsville, Ohio." Prof. Atkinson has figured this "*Chantransia*-form of *Lemanea fucina*" on plate vii. figs. 6 and 10. His meaning is therefore plain; though it is difficult to understand how he ever came to reach it. Not only is his "*Chantransia*-form" many times larger than *Ch. violacea*, but in much more important respects the resemblance is sadly to seek. Kützing's imperfect figure of his own species is probably the origin of Prof. Atkinson's mistake; but whatever var. *Beardslei* may be, it is certainly not a variety of *Ch. violacea.* More than this, it is necessary for us to prove that it is no true *Chantransia* at all. In calling it so, Prof. Atkinson of course but follows the example of Sirodot, Peter, and others in associating what appears to be a *Chantransia* with a *Lemanea.* It will be remembered that Sirodot's "*Chantransia*-forms" of *Batrachospermum* are sporophytes, but that the "*Chantransia*-forms" of *Lemanea* are protonemal merely, and bear no monospores. But *Ch. violacea* bears monospores.

Next, let us take *Ch. Boweri.* Not only have we described its monospores, but its sexual organs of reproduction as well; and it, too, grows on *Lemanea.* It is of importance to state here that we actually obtained in the same preparation, on the same slide, at one time the antherids of *Chantransia Boweri* and the antherids of *Lemanea fluviatilis* on which it grows. There could be no possible excuse for mistaking the one for the other. This interesting observation not only disposes of any question of identity between *Ch. Boweri* and *Lemanea*, but it is fatal to any ingenious theory to the effect that sexual reproductive organs might possibly be borne on the protonemal form under abnormal circumstances. Here, under the same circumstances, side by side, were these two plants both bearing antherids, and these antherids of a different type. It must be

clearly understood that we do not call in question the existence of a protonemal form of *Lemanea* which resembles, in a superficial way, *Chantransia*; nor do we contend that Peter or Prof. Atkinson are mistaken in their interesting observations except in this, that their protonemal forms are species of *Chantransia*. Enough has been said to show that this has been too hastily assumed. One might as reasonably call the protoneme of a moss the *Conferva*-form. This confusion of a protonemal form of *Lemanea* with *Chantransia* has thus been rendered worse confounded by the fact of true species of *Chantransia* growing on *Lemanea*.

The question of the asserted relationship between *Chantransia* and *Batrachospermum* is a much more difficult one; and our observations do not directly touch it. The so-called "*Chantransia*-forms" bear non-sexual spores. Are these true monosporanges or not? As bearing, however, most weightily on this question, we may here claim to have established a freshwater group of species of *Chantransia*, consisting of *Ch. Boweri* and *Ch. investiens* (the genus *Balbiania* scarcely possesses validity), in all generic points resembling the marine species *Ch. corymbifera*. They are not only reproduced non-sexually by monospores, but sexually as well. There is therefore a good and valid genus *Chantransia* in fresh water as well as in the sea; and it may be added (though a small matter, yet an indicative one) that these freshwater species exhibit that form of growth called innovation, which Mr. Harvey Gibson tells us he has observed in the marine genus *Rhodochorton*, so nearly related to the marine *Chantransia*. This being so, it appears to us that the burden of proof (in this matter of *Batrachospermum* and *Chantransia*) is shifted from our shoulders to those of M. Sirodot and his supporters—the required proof being that his "*Chantransia*-forms" are anything more than *sporophytic shoots of Batrachospermum resembling Chantransia*. We have seen how it has fared with the "*Chantransia*-forms" of *Lemanea*. It is open, of course, to those who prefer it, to contend that the sexual reproductive organs of *Ch. investiens* are merely the result of abnormal circumstances operating on a form which ordinarily is a sporophytic condition of *Batrachospermum*, for example. Here, again, let us take warning by the case of *Lemanea*. Further, the observation of these was made by M. Sirodot himself.

It would be also a possible contention that *Ch. Boweri* ought

to be reckoned with *Balbiania*; but this genus was created, its author tells us, for the reception of this form, since all other "*Chantransia*-forms" were mere sporophytic states of *Batrachospermum*. It must, therefore, now disappear. Moreover, the obvious close connexion existing with *Ch. corymbifera* warrants us in disregarding *Balbiania* as a genus, and reckoning *Ch. investiens* and *Ch. Boweri*, with *Ch. corymbifera* and other marine forms, as all of them species of a good and valid genus *Chantransia*.

EXPLANATION OF THE PLATES.

Plate XXXVI.

Chantransia Boweri.

Fig. 1. Filament bearing monosporanges, × 500.
2. Ditto, showing branches with piliferous endings, × 900.
3. Portion of filament, × 900.
4 & 5. Ditto, showing innovation, × 900.

Plate XXXVII.

Fig. 1. Trichogynes of *Ch. Boweri*, × 900.
2. Development of cystocarp of ditto, × 900.
3. Mature cystocarp of ditto, × 900.
4. Antherid of ditto, × 900.
5. Germinating monospores of *Ch. secundata*, × 900.
6. Antherid of *Ch. corymbifera*, × 250. After Bornet.
7. Trichogyne of ditto, × 400. After Bornet.
8. Cystocarp of ditto, × 250. After Bornet.
9. Development of cystocarp of *Ch. investiens*, × 720. After Sirodot.

E.S. Barton del. Highley lith.

West, Newman imp.

CHANTRANSIA BOWERI, *Murr & Bart.*

E.S.Barton del. Highley lith. West, Newman imp.

1–4 CHANTRANSIA BOWERI. *M.&B.* 5. C. SECUNDATA *Thur.*
6. 8. C. CORYMBIFERA *Thur.* 9. C. INVESTIENS *Lenorm.*

On Stipules, their Form and Function. By the Rt. Hon. Sir John Lubbock, Bart., M.P., F.R.S., D.C.L., LL.D., F.L.S.

[Read 20th February, 1890.]

Vaucher, in his 'Histoire Physiologique des Plantes,' writing of *Helianthemum*, observes:—" J'indique dans ce genre deux principaux objets de recherche. Le premier est la raison pour laquelle certaines espèces ont des stipules tandis que d'autres en sont privées." No one, however, so far as I know, has yet attempted to answer this question, which is one of considerable interest, and might be asked with reference to several other groups besides the genus *Helianthemum*.

There has been a great deal of difference of opinion as to the distribution of stipules in the Vegetable Kingdom. DeCandolle* stated without any hesitation or qualification that " Les stipules n'existent dans aucune plante monocotylédone." Others, however, have been of a very different opinion. The tendrils of *Smilax*, the ligule of Gramineæ, have been regarded as true stipules. Into this question I do not now propose to enter.

DeCandolle also observes that " Leur existence paraît cependant liée assez intimement avec la symétrie générale des plantes; car elles existent ou manquent dans toutes les espèces d'une famille: ainsi, on trouve des stipules dans les Rubiacées, les Malvacées, les Amentacées, les Légumineuses, les Rosacées, etc., et elles manquent dans toutes les Caryophyllées, les Myrtacées, etc."

This, however, is not so general a truth as DeCandolle imagined. The absence of stipules is not complete in either of the families mentioned by him. They occur not only in *Spergula* and *Spergularia*, which are now generally considered as belonging to the Caryophylleæ (though certain botanists regard the Alsineæ as constituting a separate family), but also in most of the Polycarpeæ, and among the Myrtaceæ in *Calythrix*, *Couroupita*, and perhaps in some other genera. Moreover, as pointed out in the above passage from Vaucher, there are even certain genera, and in addition to *Helianthemum* I might mention *Lathyrus*, *Genista*, *Cytisus*, *Passiflora*, *Acacia*, *Spiræa*, *Saxifraga*, *Rosa*, *Berberis*, &c., in which some species have stipules while others have none.

* 'Organographie Végétale,' vol. i. p. 334. See also Colomb, " Rech. sur les Stipules," in Ann. des Sci. Nat. 1887.

In attempting to answer this question we may begin by considering the function or functions which stipules perform. Of these the primary purpose seems to be to protect the bud. In other species, however, they serve as accessory or deputy leaves. As an illustration of the latter may be mentioned some species of *Lathyrus*, for instance *L. Aphaca.*

Passing on now to the cases in which the stipules serve to protect the young leaves, I may first mention, in passing, those instances in which the stipules with this object have become stiff, pointed, and thorn-like, as in *Robinia.* They are especially developed on the lower shoots and branches, which most need protection.

In far more numerous species, however, the stipules protect, by enveloping, the young bud and leaves. In such groups the view that the function of the stipules is mainly to protect the young leaf is confirmed, not to say proved, by the fact that they are very short-lived and drop off as soon as the young leaves have expanded. Such cases are so numerous that it is hardly necessary to quote any illustrations. Indeed, in many of the lesser known genera this early fall of the stipules leaves it doubtful whether they occur or not.

On the other hand, there are cases in which protective stipules are even more persistent than the leaves to which they belong; in such cases, however, they protect, not their own leaf, but that of the following year.

Passing now to the case of *Helianthemum,* let us compare the species which have, with those which have not, stipules. Our common *H. vulgare* (fig. 1) is one of the species with stipules. The leaves are oblong-lanceolate, subacute, opposite, petiolate, stipulate, channelled above, and thinly covered with stellate tufts of hairs, and finely tomentose with similar tufts beneath. Some varieties are even more nearly glabrous, others more decidedly tomentose. Petiole *narrowed* to the base, semiterete and flattened above, glabrous or nearly so. Stipules subulate, acute, one-nerved, ciliate, inserted on the very base of the petiole.

Another species with stipules is *H. polifolium.* Here the leaves are opposite, petiolate, stipulate, lanceolate, obtuse, terminated by a bristle, channelled above and finely pubescent, carinate beneath, with midrib densely tomentose and hoary. The petiole is slightly tapered to the base, narrow, semiterete,

silky. The stipules are small, subulate, acute, one-nerved, densely ciliate on the margins and keel, seated on the very base of the petiole.

Fig. 1.

Shoot of *Helianthemum vulgare.* Slightly enlarged.

Again, in *H. tomentosum* the leaves are opposite, stipulate, oblong, obtuse, broad at the apex, and tipped with a bristle, channelled along the middle, hoary and tomentose on both surfaces with adpressed tufts of stellate hairs. The stipules are small, subulate, acute, obscurely one-nerved, hairy or silky. The petioles semiterete, slightly tapered to the base, silky.

In *H. ægyptiacum* the leaves are ovate, obtuse, thinly hairy, with stellate tufts of hairs. The stipules lanceolate-subulate, moderately large; otherwise like *H. vulgare.*

In *H. rhodanthum* the leaves are opposite, linear, obtuse, revolute at the margins, petiolate, stipulate, channelled above, deep green, and covered with stellate hairs, hoary beneath and densely felted with stellate hairs. Petiole *tapered* slightly to the base, semiterete. Stipules small, subulate, one-nerved, hairy, on very base of petiole, which widens there and shows an attempt at being connate at the base.

The leaves of *H. ciliare* are oblong or oval, obtuse, thinly stellately hairy above and at the margin, nearly glabrous beneath.

Stipules rather large, lanceolate-subulate, hairy. Otherwise like *Helianthemum vulgare.*

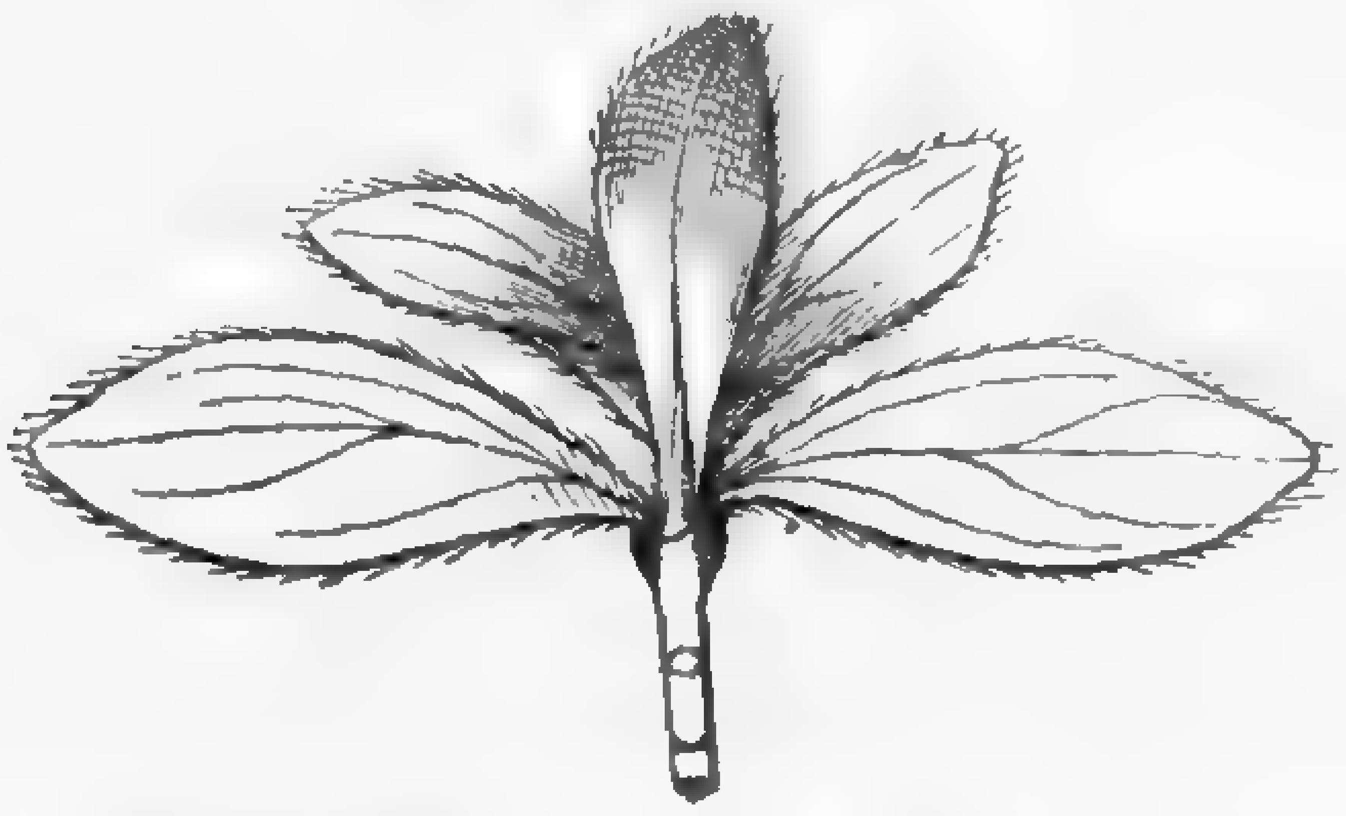
In *H. lavandulæfolium* the leaves are narrowly oblong, obtuse, thinly stellately hairy above, densely felted beneath; otherwise like *H. vulgare.* Stipules small, subulate.

H. rosmarinifolium ? has its leaves ½ in. to 1¼ in. long, oblong, obtuse, thinly stellately hairy above, densely felted and hoary beneath; otherwise like *H. vulgare.* Stipules long, subulate, acute.

In all these species the petiole tapers more or less towards the base.

Now let us turn to the species without stipules. Beginning with *H. œlandicum* (fig. 2), the plant is dwarf and prostrate. The

Fig. 2.



Shoot of *Helianthemum œlandicum.* Slightly enlarged.

leaves are opposite, exstipulate, oblanceolate or spathulate, tapering to a broad base, sessile, often but not always distinctly three-nerved, ciliate, especially at the base, and hairy on the midrib beneath, *sheathing* the apical bud very closely in the young state.

H. lasianthum is a suberect and shrubby species. The leaves are oblanceolate, or spathulate, obtuse, undulate at the margin, tapering to a short petiole which is *distinctly widened* at the very base, and sheathing the bud in a young state, stellately pubescent above and densely felted beneath.

H. ocymoides has its leaves oval obtuse, tapering into a petiole which is grooved above, dilated and *sheathing* the bud by its base, hoary, and densely felted with stellate pubescence on both surfaces.

H. formosum is a shrub of similar habit to the last. Its leaves are oblanceolate, obtuse, or the larger ones oblong, three-nerved, densely felted on both surfaces and hoary, with stellate tomentum, undulate at the margin, tapering into a broad flat petiole, which

is *dilated* at the very base and *semiamplexicaul.* In the young state the petioles are shorter, deeply grooved on the inner surface and half surround a young bud in their axil. The bud, meanwhile, of the main axis is completely covered by its own densely felted leaves, which are opposite, decussate, valvate, and clasp or adhere to one another by means of the tomentum.

Helianthemum Libanotis is an upright, small, twiggy shrub. Its leaves are narrowly linear, obtuse, strongly revolute at the margin, *sessile,* slightly tapering to the base and *again dilated* there, sheathing or rather clasping the stem (amplexicaul), deep green above and finely scaly, felted beneath with a fine tomentum of short stellate hairs. They are also opposite, decussate, completely sheathing the bud in the young state, and slightly connate at the base, even after attaining full size.

Thus in all the above cases the species with stipules agree in having narrowed petioles, and the young bud is sheltered by the stipules. On the other hand, in the second group which has no stipules the petiole itself is more or less widened or sheathing and serves to protect the bud.

The reason for the presence or absence of stipules seems then quite obvious. When present the petiole is always very narrow, semiterete, and tapered to the base. In the bud state the stipules of two opposite leaves seem like another pair of smaller leaves set on at right angles to the first. They touch by their contiguous edges and diverge at an acute angle over the enclosed bud, filling the open space between the leaves. Where stipules are absent the leaf is often sessile, and, whether or not, its base is always dilated and concave on the inner face, completely enclosing the bud up to a certain stage of its development.

Let us now see whether the conformation of other species supports this view. In the allied genus *Cistus,* the species of which possess no stipules, the petiole is widened as in the *Helianthemums* without stipules. For instance:—

Cistus villosus, like all the undermentioned species, has no stipules. Its leaves are oblong-oval, rugose, villous, tapering into a broad subwinged petiole, which is dilated at the base and connate for 2–2½ millim., enclosing the bud when young and the axis when old.

C. corbariensis differs markedly from the above in its well-defined petiole. Its leaves are cordate-ovate, acute, dark green, and very rugose, glabrous, distinctly petiolate. Petiole semi-

terete, channelled above, dilated to a broad stout base, which shelters the young bud, slightly *connate* for about $\frac{1}{3}$ millim. at the very base.

Cistus laurifolius has its petioles connate and sheathing at the base. The leaves are ovate or lanceolate, acuminate, 3-nerved, leathery, glabrous above, tomentose beneath, petiolate. Petiole semiterete, flat above, sheathing and *connate* at the base, forming a cup about 3 millim. deep, hairy and covered with an *adhesive gum*, as is the stem.

C. ladaniferus var. *angustifolius* differs from the last in having its leaves lanceolate-oblong, obtuse, sessile, tapering to a broad amplexicaul base, *connate* for 1 millim., enclosing the bud in the young state, and forming a cup round the axis afterwards.

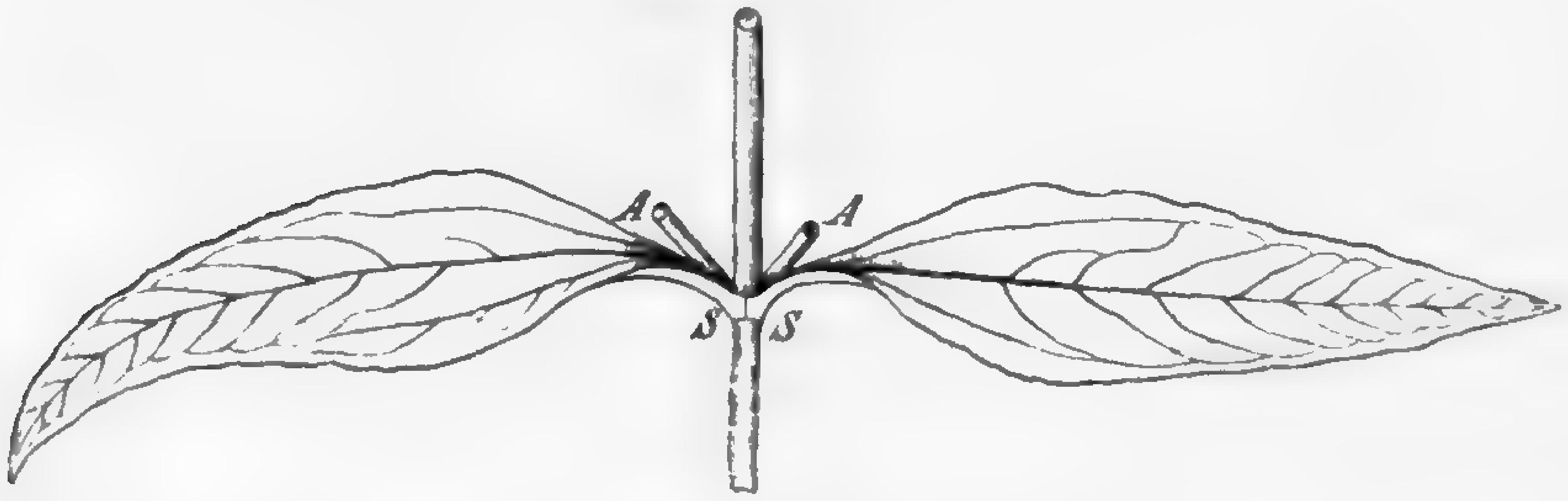
C. longifolius has its leaves lanceolate, undulate, rugose, narrowed to a short, winged, petiole-like base, dilated at the base and connate for $\frac{1}{4}$–$\frac{1}{2}$ millim., completely enclosing the bud in the young state.

The leaves of *C. monspeliensis* are small, oblong-lanceolate, obtuse, 3-nerved, revolute at the margin, *sessile, amplexicaul*, thinly hairy, but almost woolly at the edges, but more especially close to the base, *connate* for $\frac{1}{4}$–$\frac{1}{2}$ millim., and completely enclosing the bud.

In *C. platysepalus* the leaves are oblong, obtuse, 2–3 inches long, 3-nerved at the base, slightly narrowed there, sessile, connate for $\frac{1}{4}$–$\frac{1}{2}$ millim., erect when young and completely enclosing the bud.

The leaves of *C. cyprius* (fig. 3) are lanceolate, acuminate,

Fig. 3.



Shoot of *Cistus cyprius*. Reduced $\frac{1}{2}$.
S S. Connate sheaths of leaves. *A, A*. Axillary shoots.

3-nerved, very leathery, subglaucous above from a covering of grey scales, silvery grey beneath from a dense felt of stellate

hairs, petiolate. The petiole is semiterete, flattened above, dilated, sheathing and connate at the base for 2–2½ millim., light greenish yellow, as is the axis, and covered with gum.

Thus, then, in the absence of stipules the bases of the leaves are connate and sheathing (even when the leaves are petiolate), so that stipules are unnecessary. The base of the petiole in *Cistus corbariensis* is very much dilated and unusually stout or thick, so that the axial bud is well protected, although both sheath and stipules are absent.

I will now proceed to remark on some of the other families which are most interesting from this point of view.

Magnoliaceæ.

Among the Magnoliaceæ stipules are present in *Magnolia*, *Liriodendron*, &c. I have already described the stipules in the latter genus (Journ. Linn. Soc. Bot. xxiv. p. 84), where they enclose and protect the bud, but in other genera they are entirely absent. In *Drimys* (*D. Winteri*) they are replaced by some of the outer leaves of the resting bud, which are reduced to bract-like fleshy scales. The leaves are convolute, the lower enclosing the upper ones.

Again, in *Kadsura* (*K. japonica*) the winter-buds are protected by the outer leaves, which are reduced to scales, and appear to consist of flattened petioles, with a membranous margin representing stipules free only at the tip. The true leaves follow the scales abruptly. As in *Drimys* the lower leaves completely cover the upper ones. In these respects *Schizandra* (*S. chinensis*) closely resembles *Kadsura*.

Berberideæ.

Epimedium (*E. pinnatum*) has large, membranous, brown, intrapetiolar stipules. The petioles are quite terete.

In *Podophyllum* (*P. peltatum*) the base of the petiole is deeply concave, produced into broad membranous sheaths, with triangular, or rounded, free ends representing the stipules.

In *Holbœllia* (*H. hexaphylla*) there are no stipules, but the resting bud is protected by scales which show traces of stipules in being tridentate at the apex. The same occurs in *Stauntonia* (*S. latifolia*). In the true leaves the function of stipules is performed by the persistent pedestal, as is also the case in *Akebia* (*A. quinata*).

Berberis itself (*B. Aquifolium*) has the petioles dilated and sheathing at the base, the membranous margin being detached in its upper part. The winter-bud is protected by scales consisting of thin sheaths. They are shortly trifid at the apex, the central tooth representing the rudiment of the leaf. As regards the rudimentary stipules, *B. glumacea* resembles *B. Aquifolium*, as also does *B. juglandifolium*.

On the other hand, in *Berberis japonica* the leaves are exstipulate, but the petioles are undeveloped, and the lowest pair of leaflets are attached close to the upper edge of the sheath, so that they perform the function of stipules. The winter-bud, however, is covered by numerous large scales which show clear indications of stipules, being distinctly tricuspidate at the apex. Some of the scales bear a rudimentary lamina, with minute leaflets that never increase in size, but soon become black.

Bixineæ.

The genus *Azara* has stipules and the petiole is terete, but I mention it particularly because in some species the stipules are remarkably unequal. In *A. dentata* the two rows on the upper side of the branches are foliaceous and evergreen, resembling the leaves in shape, toothing, texture, and hairiness; while the two rows on the lower side of the branches are minute, subulate, hairy, and brown or black in winter. The two sets are also very unequal in *A. microphylla* and *A. Gillesii*. In *A. celastrina*, on the other hand, both series are minute.

Caryophylleæ.

Spergula, *Spergularia*, and most of the Polycarpeæ have well-developed stipules. The leaves are sessile, either terete or narrowed at the base.

In the species of Caryophylleæ without stipules the reverse is the case.

In *Dianthus Caryophyllus*, for instance, the leaves are opposite, linear, acuminate, acute, carinate beneath, channelled above, glaucous, glabrous, entire, sheathing at the base and *connate* for 6–7 millim. of their length, and remaining so till leafy buds in the axils of the leaves burst the sheaths.

Other species of *Dianthus*, of *Tunica*, *Gypsophila*, *Saponaria*, *Silene*, *Lychnis*, *Cerastium*, *Arenaria*, and *Sagina*, so far as I have examined them, all agree in having the basal parts of the leaves more or less connate and sheathing.

Guttiferæ.

In the Guttiferæ stipules are absent, except in the genus *Quiina*.

As typical instances of the species without stipules I may take *Clusia rosea*, in which the leaves are opposite, entire, obovate, rounded at the apex, tapering to the base, petiolate, thick, coriaceous, glabrous, deep green above, paler beneath. Petioles more than half terete, flattened above, thickened and slightly dilated at the base, where they are furnished with a small ovate cushion-like process. The resting-bud is protected by the last-developed pair of leaves; the petioles are erect at the basal part and closely applied to one another, the cushion-like process being then concave with slightly raised edges, which form the line of contact. The bud is accommodated in the hollow space between the cavities of the two petioles.

In other species also of this genus the petioles are grooved, and cover the bud in the young state.

Again, in *Garcinia Mangostana* the leaves are oblong-elliptic, leathery, glabrous, and deep green above. The petiole is about ½ in. long and developed at the base in the same manner as *Clusia*, although the cushion is not of very large size.

Xanthochymus pictorius, allied to the last, has its leaves opposite, oblong-elliptic, shortly petiolate, rather closely feather-nerved, with the veins at right angles to the midrib, or nearly so. The petioles are furnished at the base with a triangular, narrow and elongated, ridge-like elevation of parenchyma. The ridges of the last-developed pair of leaves are closely applied to one another and protect the terminal buds.

On the other hand, the genus *Quiina* has stipules. *Quiina rhytidopus* has the leaves opposite, persistent, coriaceous but rather thin, lanceolate or oblong, obtuse, entire, shortly petiolate. The petioles are comparatively slender and not thickened at the base like the above-described species belonging to other genera, but are provided with a pair of stipules. The stipules are subulate, acuminate, slender, 6–8 millim. long, ½–1 millim. wide, persistent.

Simarubeæ.

The Simarubeæ also are described as exstipulate, with the exception of *Rigiostachys*, *Brunellia*, *Irvingia*, and *Cadellia*. In *Ailanthus glandulosa*, however, the lower leaves have well-

developed subulate stipules. The winter-bud is protected by brown scales. Then follow some small leaves with a short, membranous, much dilated petiole, and a small, irregularly toothed or lobed lamina. The stipules occur irregularly on the imperfect leaves. The lowest perfect one has, sometimes, one or two stipules. A few of the others have small, triangular, rudimentary stipules, and on the others they are entirely absent.

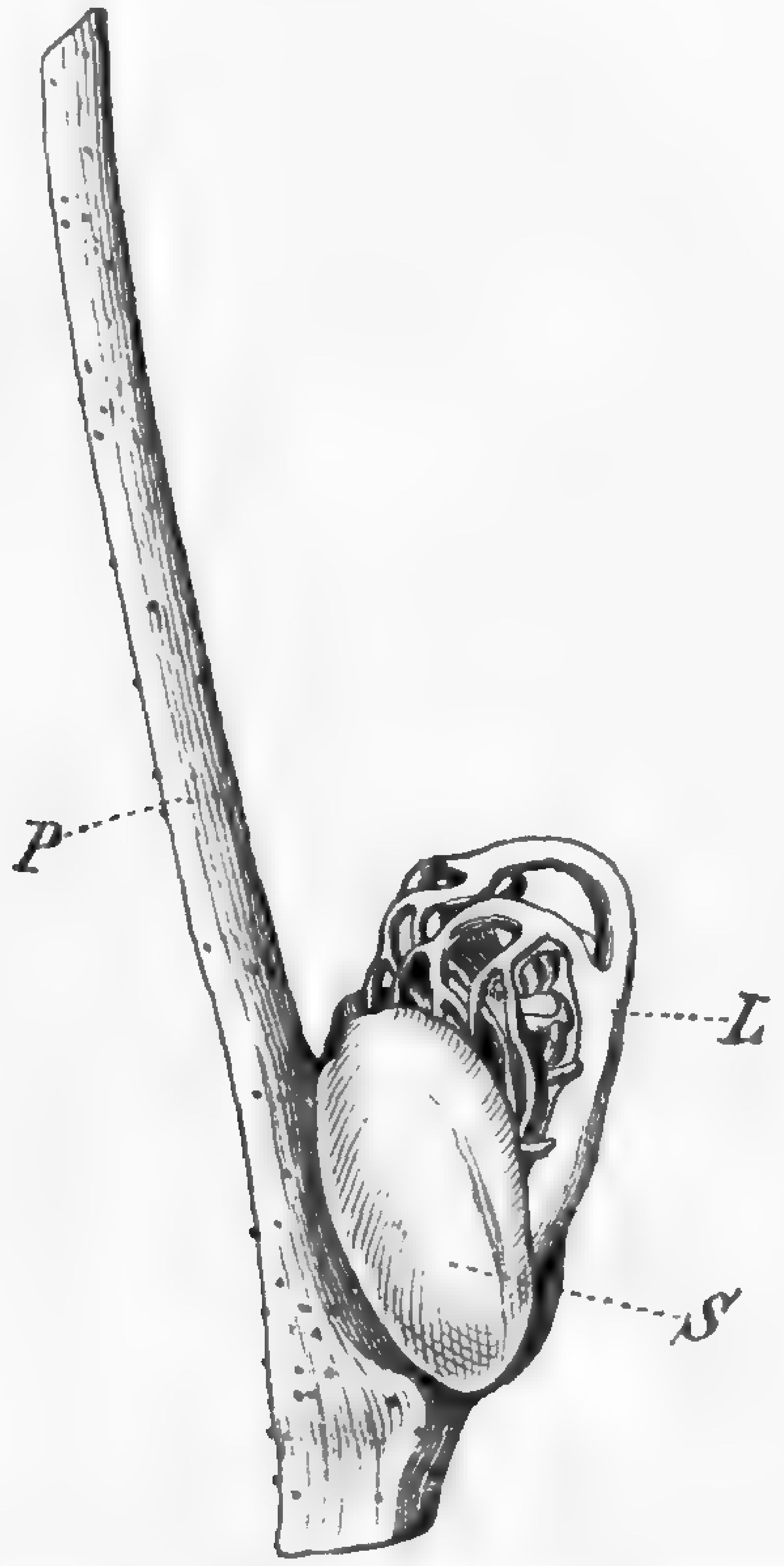
Ilicineæ.

This order is generally described as exstipulate. In *Prinos*, however, there are well-marked triangular-subulate stipules, which are especially pronounced in the winter-bud. The Holly also (*Ilex aquifolium*) has similar, but minute, black points at the bases of the leaves.

Ampelideæ.

In the Vines (*Vitis vinifera*, &c.) the stipules are large, and

Fig. 4.



Shoot of *Leea coccinea*.—*P*. Petiole of leaf, the lamina being cut off. *S*. Stipule. *L*. Young leaf emerging from stipules.

appear so much in advance of the leaves that they cover the whole bud, including their own leaf. They fall early. In *Leea*

(*Leea coccinea*) they are also (fig. 4) large, oblong oval, obtuse, and enclose the whole bud, but they are persistent. Their own leaf is developed under the protection of the stipules of the preceding leaf, and they themselves cover the one which is to follow.

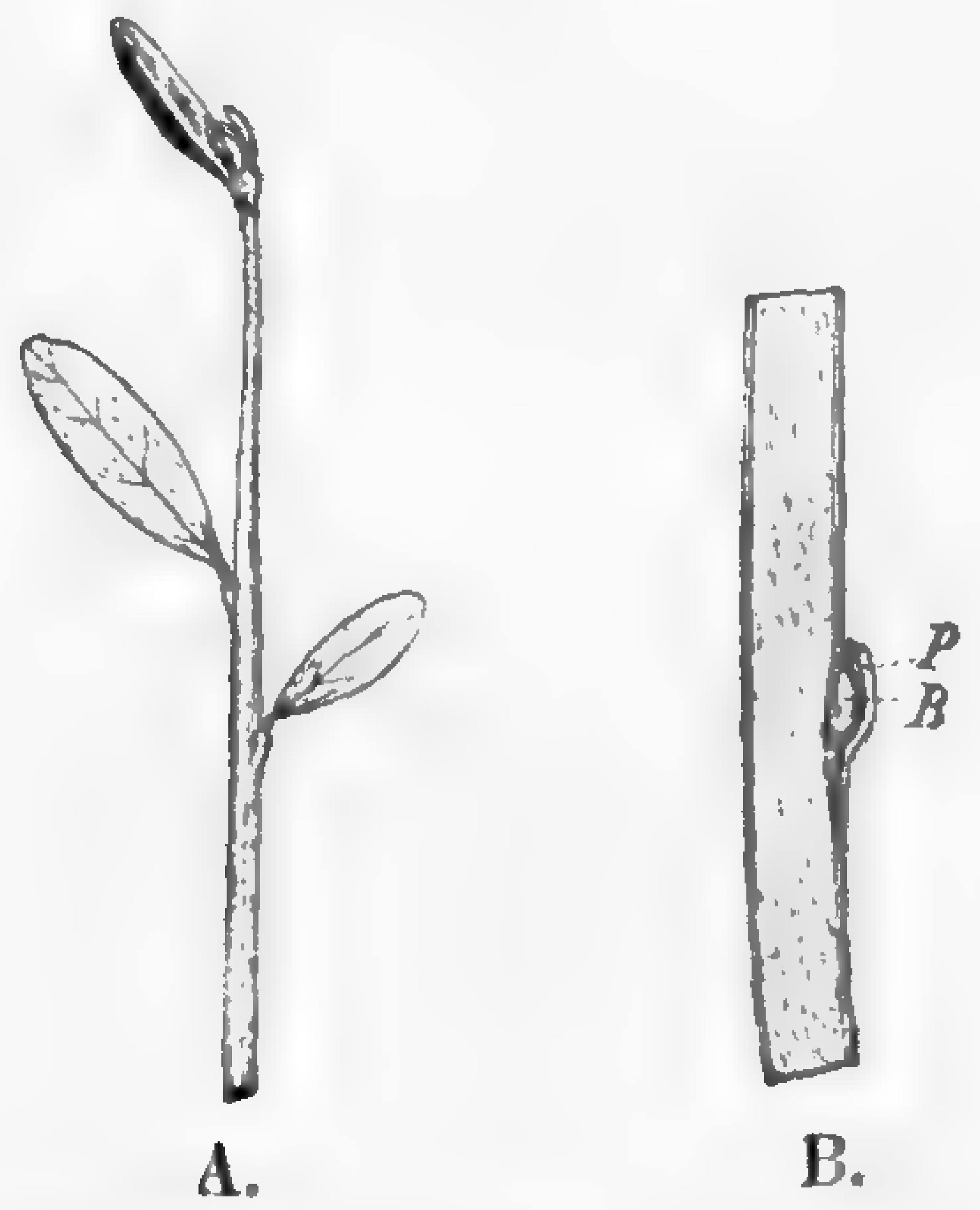
Leguminosæ.

In this great family there is much variety as regards the stipules. In some cases they are well developed, as for instance, to mention among English genera only, in many species of *Ononis*, *Medicago*, *Melilotus*, *Trifolium*, *Astragalus*, *Oxytropis*, *Vicia*, *Lathyrus*, &c. In *Lathyrus Aphaca* indeed they replace and perform the function of leaves.

In the Laburnum the petiole is long, slender, and subterete. The stipules are long, narrow, and caducous, reaching to 2–10 millim. in length. In the early stages of the growing bud the pedestal is developed, but not the petiole. The stipules are short and occupy the space at the base of the lateral leaflets. The leaf at this stage appears to consist of five leaflets, the lowest pair, however, being the stipules. They differ from the leaflets in being flat—not conduplicate.

In *Wistaria*, the pedestals of the upper leaves become

Fig. 5.



Shoots of *Spartium junceum.*—A. Reduced ½. B. Part of do., to show the bud protected by the pedestal of the fallen leaf; nat. size.

gibbous behind and thus form two projections in line, and apparently continuous, with the stipules. They are evidently intended to assist the plant in climbing.

In many species the stipules are so much reduced as to be

apparently functionless, so far as the terminal bud is concerned. This is the case, for instance, in *Eutaxia myrtifolia* and *Spartium junceum* (fig. 5), where the pedestals of the petioles are elongated, concave, and persistent, thus effectively protecting the young bud during winter, and subsequently the young leaves, aided slightly by the minute, but persistent, stipules. The young leaves also are covered with silky grey hairs.

In *Robinia* (*R. Pseud-Acacia*) the winter-bud is protected by three short, brown, triangular, persistent scales. They almost look like bark, but are densely lined internally with a grey fur or tomentum. On the young growing shoots the stipules are linear, subulate, slender, and hairy. Ultimately they thicken and become woody, brown, persistent spines. They are less developed on the upper branches, which need less protection. Here, therefore, they serve rather for the general protection of the plant than for that of the buds. In other species of the genus this protection is afforded in other ways. In *R. hispida*, for instance, by bristly hairs; in *R. viscosa*, by a gummy substance which exudes from small, globular, reddish glands. In the genus *Lotus* the lower leaflets resemble, and have been regarded by some Botanists as, true stipules. There are, however, minute glandular teeth, which appear to be the true representatives of stipules.

Genera without Stipules.

Some Leguminosæ present no trace of stipules. This is, for instance, the case in *Ulex* (*U. europæus*), where the bases of the leaves are dilated. In *Sophora* (*S. MacNabiana* and *microphylla*) the protection of the young leaves is effected by their being densely covered with short, adpressed, brown hairs. In *Cladrastis* (*C. amurensis*) &c., again, the growing bud is protected by a dense felt of hairs, and the winter-bud is covered by from four to six scales.

Genera in which some species have, and others have not, Stipules.

In certain genera some species have, and others have not, stipules. Thus in *Genista tinctoria* the stipules are subulate-triangular, acute, short, and seated on the persistent and elongated pedestal of the leaf. In the bud they occupy the space left where the leaf narrows to the base, and it almost seems as if they had been separated from the leaf so as to allow it to become

disarticulated above the sheath. The winter-bud is protected by scales, consisting of reduced leaves, on which the stipules are scarcely perceptible. In *Genista antarctica* and *G. sagittalis* the stipules are similar in type, but minute. In *G. virgata* the shoots die at the tips, so that there are no terminal buds. The pedestals are densely lined with hairs on the inner surface. *G. hispanica* has no stipules, but the bud is protected by scales, which are ciliated at the margin and hairy. There is also a dense mass of hairs on the axis.

Spartium junceum agrees in the absence of stipules; but in this species the young bud is protected by the enlarged, concave, persistent, pedestals of the last year's leaves.

Cytisus is another genus in which some species have stipules and others not. Those of the Laburnum have been already mentioned. We may divide the genus into three types:—those with moderate-sized stipules; those with minute stipules; and those with none.

In *C. racemosus*, *C. canariensis*, *C. stenopetalus*, &c., the stipules are oblong or subulate-oblong, obtuse, densely hairy especially on the inner side; and though small, assist in protecting the bud. The growing buds form a dense rosette. There are no bud-scales. The axillary buds are protected by the petiole and stipules. The pedestal, which in other species, as we shall see, plays so important a part, is scarcely evident.

In a second type, of which the Broom (*C. Scoparius*), *C. albus*, *C. sessilifolia*, &c., may be taken as representatives, the stipules are minute and the lateral buds are mainly protected by the concave, persistent, pedestals of the leaves. The winter-bud is protected by two small scales and by a dense covering of hairs. In most, if not all, the species of this group, moreover, the apices of the twigs die in winter, so that all the buds are then axillary.

In a third type, *C. serotinus* for instance, the stipules have entirely disappeared. The axillary buds are protected by the broad, concave, persistent pedestals; the terminal buds by short, brown scales, which pass by a series of gradations into true leaves. These scales are trifid at the apex, but the lateral teeth represent leaflets, not stipules. *C. nubigenus*, *C. filipes*, *C. proliferus*, *C. capillatus*, *C. uralensis*, *C. nigricans*, *C. purpureus*, &c., agree in the absence of stipules.

Again, in the genus *Acacia*, *A. cordata* has triangular, or subhastate, acuminate, spiny phyllodes; and the stipules are

filiform, broader and flattened at the base, finely pubescent, brown except at the base, and erect. They are developed in advance of the phyllodes, and project beyond them, thus forming a dense brush which protects the phyllodes in bud.

Acacia verticillata and some nearly allied species constitute a very instructive and interesting case. *A. verticillata* has linear, pointed, laterally compressed phyllodes, arranged in whorls, so that it has very much the look of a strong *Galium*. Buds only occur here and there along the stem, and the phyllodes generally have no stipules, their presence depending on whether there is or is not a bud. If there is no bud there are no stipules; while if a bud is formed, stipules are also developed (fig. 6).

Fig. 6.

Shoot of *Acacia verticillata*. *S*, *S*. Stipules. × 1½.

In *Piptanthus* *P. nepalensis*) the stipules are quite free from the leaf to which they belong, but inserted on the stem, with which they form a continuous connection all round. They are connate, but free for a short distance at the apex, with ovate, acute tips. In the bud state, each pair of stipules covers the whole of the younger organs, only leaving exposed the short petiole and the midribs of the leaflets of the leaf to which they belong, which, however, are covered by the stipules of the next older leaf.

Lastly, in some Leguminosæ, as for instance in *Aotus gracillima*, the stipules are reduced to glands.

Anacardiaceæ.

The Anacardiaceæ are generally exstipulate, or the lower pair of leaflets of compound leaves are stipuliform.

In *Corynocarpus* (*C. lævigatus*), however, the stipules are well developed and intrapetiolar. The leaves are simple, entire, alternate, stipulate, petiolate, feather-nerved, with ascending sub-incurved veins, glabrous, shining on both surfaces, evergreen, narrowly obovate, cuspidate, tapering much to the base, scaly and glandular when young; the petioles are short, stout, semi-terete, and of equal width throughout, articulated with the stem; the stipules *intra-petiolar*, connate, forming one ovate obtuse, two-nerved, membranous piece, colourless but soon turning brown, *caducous*, becoming disarticulated from the stem along a line *on a level* with the upper edge of the petiole and leaving a scar ultimately extending more than halfway round the stem. That the piece really consists of two stipules is evidenced by the two vascular bundles, which take their rise at the edge and base of the petiole, above which they converge considerably in the stipular body. The leaves are arranged on the $\frac{2}{5}$ plan, and in bud they are conduplicate, enclosing all the younger leaves; at the base they taper away into the petiole, but the intrapetiolar stipules closely invest all the rest of the bud with the exception of the very base of the midrib of the next leaf. The whole bud is then covered by *one* leaf with its *stipules* together with the *midrib* of the next. It takes three leaves, however, to make a complete spiral round the axis.

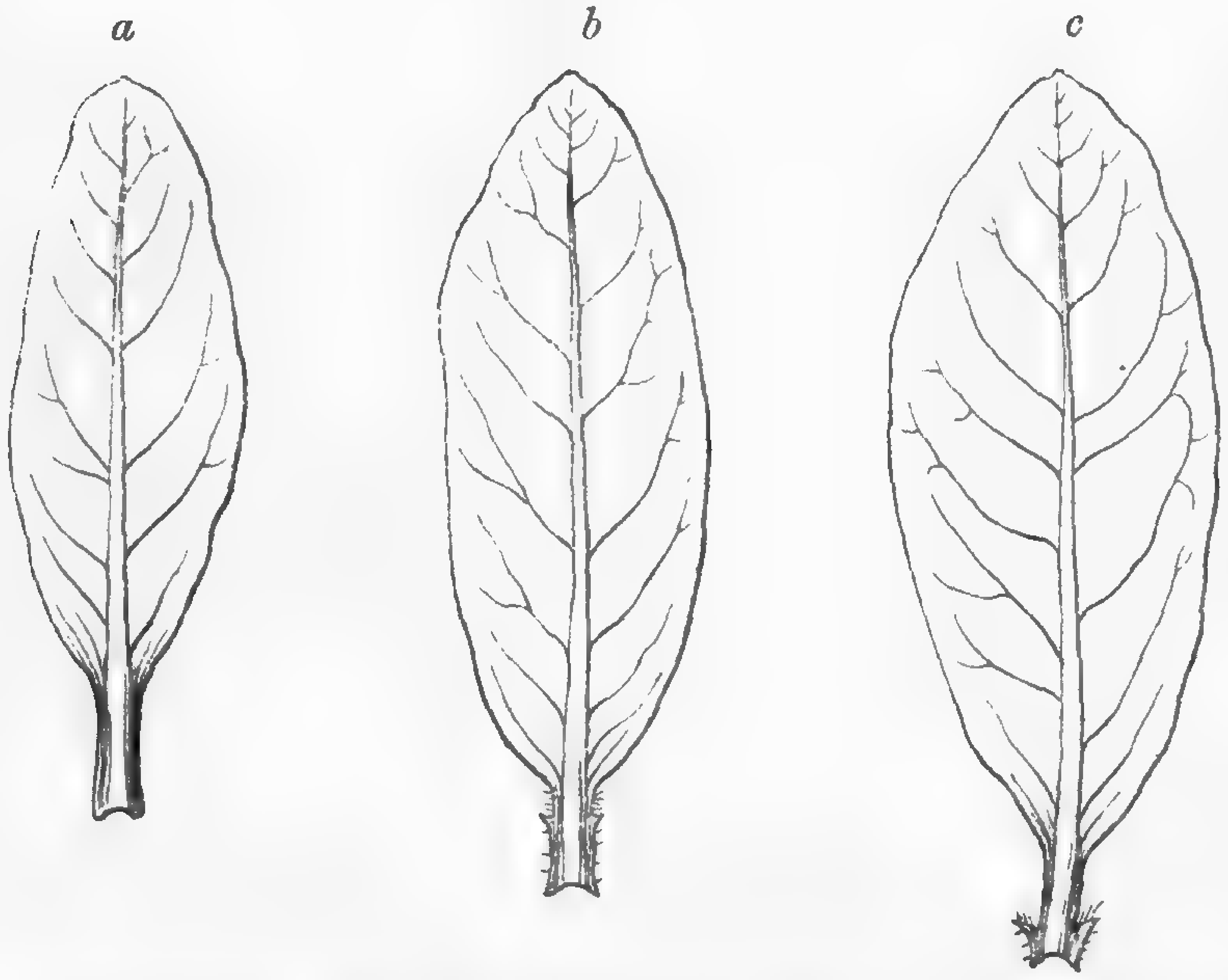
Rosaceæ.

The Rosaceæ are another family in which, while stipules are generally present, in some genera they are obsolete or altogether absent. *Exochorda* (*E. grandiflora*), for instance, is exstipulate. The petiole is concave and amplexicaul, and the winter-bud is covered with a number of broadly triangular brown scales, some of which show indications of being tridentate at the apex. These lateral teeth are probably evidence of the former existence of stipules. The petiole of the lower leaves also sometimes shows short teeth at its upper end, which also probably represent the last trace of stipules.

In most of the Rosaceæ the buds are protected by scales. These, however, are wanting in *Eucryphia* (*E. Billardieri*), but the buds are protected by stipules which are intrapetiolar, connate, coriaceous, and bear on their inner surface a number of orange-coloured glands. These secrete a quantity of yellow gum,

which helps to constitute a very efficient protection. *Eucryphia pinnatifolia* is provided with similar, but smaller, glands. The genus *Nuttallia* is described by Bentham and Hooker as exstipulate. *N. cerasiformis*, however, appears to present a very interesting gradation. The winter-bud is covered with numerous

Fig. 7.



Leaf of *Nuttallia cerasiformis*.—*a*. With entire sheath. *b*. Showing indications of stipules. *c*. With stipules in ultimate form.

scales, which are leaves wholly reduced to their sheaths: the outer ones very short, rounded, ovate, or triangular, not lengthening when growth commences: the inner ones lengthen, becoming linear, cuspidate, concave, rolled round the bud, pale green, almost colourless, membranous and ciliate at the margin.

The first leaf in the bud having a lamina is spathulate, with the petiole transformed into a grooved sheath, membranous at the margin right up to the base of the lamina; the second and third leaves have a similar but shorter sheath, and oblong lamina; the fourth leaf is oblong or oblanceolate, with the membranous sheath partly separated from the petiole, and forming stipules still adnate for the greater part of their length; the fifth and sixth leaves are similar with shorter petioles, and shorter, but more evident, stipules. Here, then, we have in the bud a gradual transition from leaves wholly reduced to sheaths, to those with a lamina and a sheath, then to those with a lamina, petiole, and

stipules, the latter being adnate to the petiole for a greater or less part of their length.

Several other genera of Rosaceæ (*Cratægus*, *Pyrus*, &c.) present us with cases of polymorphic stipules. In the Quince (*Pyrus japonica*), for instance, we have the following series:—1st. The scales of the winter-bud are very broad, short, deeply trifid or almost tripartite, deep brown or black; the lateral lobes are the largest and are the stipules. 2nd. Fascicles of leaves are produced along the sides of the previous year's wood, and the stipules on the outer ones are reduced to small blunt teeth. 3rd. Those towards the centre of the fascicle bear subulate or linear stipules, with a distinct midrib. 4th. On the base of the elongating shoots the stipules are lanceolate, shortly stalked, acute, and one-nerved. 5th. The stipules gradually widen on succeeding leaves, till they become broadly and obliquely reniform, dentate, with the midrib nearest the anterior side and running into an acute point, copiously reticulate, shortly petiolate, foliaceous, with large auricles passing round the axis until they meet on the opposite side. The scales of the winter-bud persist for some time at least after the expansion of the leaves and offer some protection. There would be no need, nor room, for large stipules in the fascicles of leaves, as the older protect the younger.

Stipules often disappear, or nearly so, when the leaves become fascicled in dense rosettes. The large reniform stipules are folded round the sides of the convolute leaves which enclose all the younger members; one leaf encloses the whole of the upper portion of the bud, while the stipules protect the lower lateral portions where the leaves narrow into the petiole. The internodes are rather elongated, and the large stipules would be of importance or of use indirectly by increasing the area of leaf-surface. The petioles, I may add, are subterete.

In the genus *Spiræa* we find remarkable differences, offering an interesting analogy with those which occur in *Viburnum*. The simple-leaved species of the genus (*S. lævigata*, *S. Douglasii*, *S. tomentosa*, &c.) have no stipules. The winter-buds are protected by brown, ciliate scales, which gradually pass into true leaves. On the other hand, the compound-leaved species have well-developed stipules. In *S. sorbifolia*, &c., they are lanceolate or oblanceolate and protect the buds. The winter-buds are also

covered with scales; these are trifid, representing the petiole and two stipules.

SAXIFRAGEÆ.

Some genera have, while others have not, stipules. This family is also especially instructive because the genera differ greatly in habit.

Species with Stipules.

Astilbe japonica.—The leaves are radical and cauline, bi- triternately compound, with long, almost terete petioles, and a long, narrow, shallow groove on the upper side. The stipules of the radical leaves form a large fleshy sheath, with a membranous margin, surrounding the winter-buds; those of the lower cauline leaves are separated from the petiole for the greater part of their length, completely surrounding the stem, but not connate, forming two or three broadly triangular, membranous, cuspidate pieces, wrinkled, white at the base and brown above. The upper cauline stipules are similar but smaller, and less completely surround the stem.

Tellima grandiflora.—The stipules are large, and united to the petioles by their edges for $\frac{3}{4}$ of their length, pale green, membranous, ciliate at the margins; they are, in fact, the sheath of the leaf, separated at the upper end. The axillary buds have the first leaf reduced to its sheath.

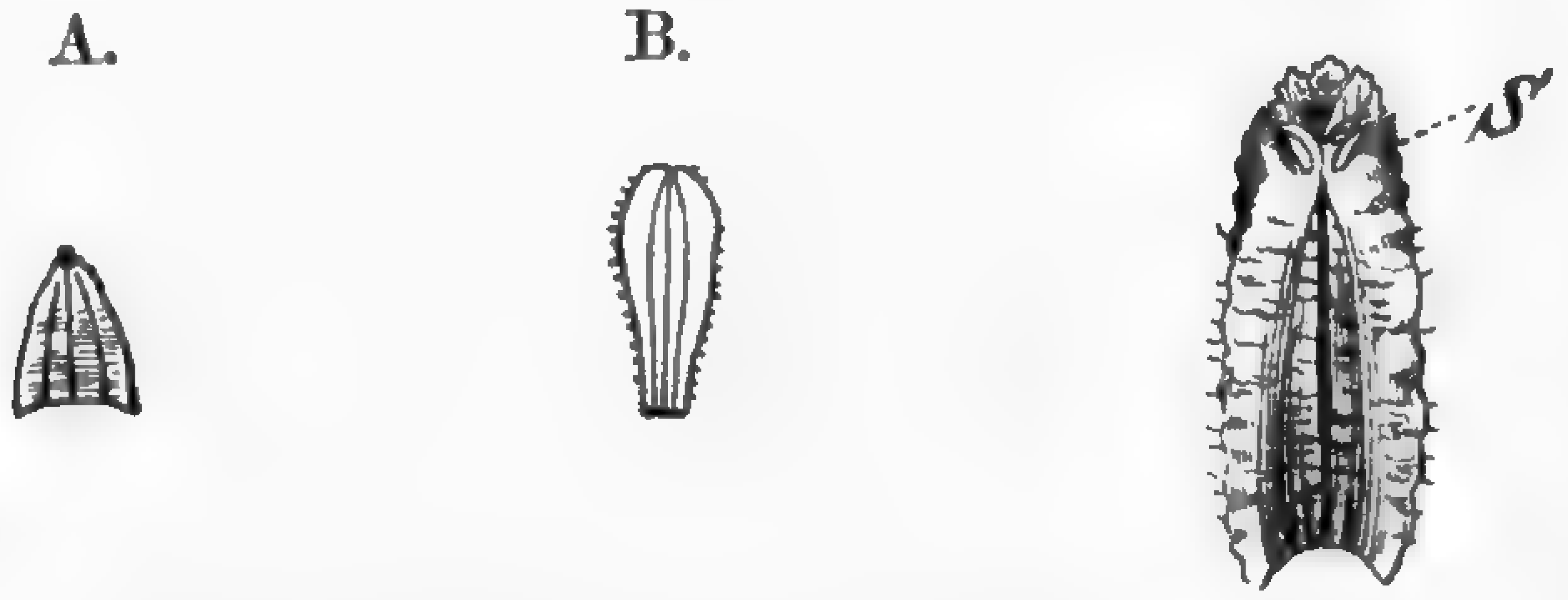
Tolmiæa Menziesii.—In this species there are large and well-developed, nearly membranous stipules at the base of the hairy, terete petioles. They are morphologically developments of the *sheath* of the leaf, to the side of which they are attached by their edges for $\frac{3}{4}$ or more of their length, as seen in different species of *Rosa*. The free ends are rounded or triangular and ciliate-serrate. The first leaf of the axillary buds is generally, if not always, reduced to an entire, concave, or boat-shaped sheath, with the midrib representing the petiole sometimes excurrent as a short bristle. At the base of the lamina of each leaf a bud is in nearly all cases developed, continuous with the apex of the petiole. The first leaf of this is also reduced to an entire sheath, while succeeding leaves have a lamina and well-developed stipules.

Mitella cordifolia.—In this species the leaves are tufted, dwarf, petiolate, and with sheathing bases to the petioles. The free portion of the sheath is short, rounded, and ciliate. In

Mitella nuda the stems form long, slender, creeping, and rooting rhizomes, with orbicular, doubly crenate, hairy, stipulate leaves, with a cordate base. The stipules are small, adnate to the base of the petiole, free from it for about $\frac{1}{3}$ of their length, surrounding the stem, but scarcely connate.

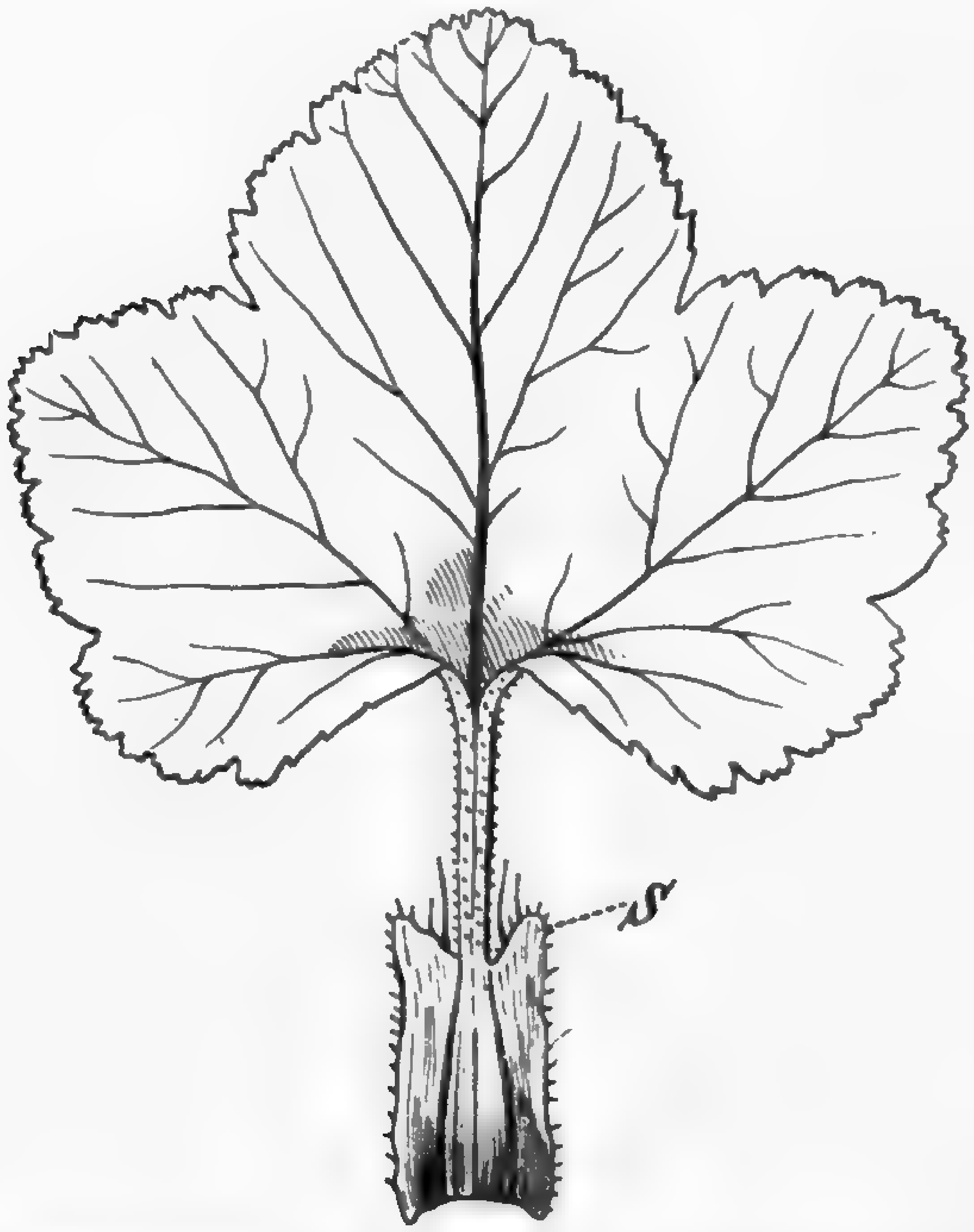
Fig. 8.

A. B. C.



A. *Ribes sanguineum.*—Outer bud-scale with 3 vascular bundles; stipules indicated by lateral teeth at the tip.
B. *Ribes sanguineum.*—Inner bud-scale, with broader membranous margin.
C. *Ribes sanguineum.*—Intermediate form between bud-scale and leaf. *S.* Stipule.

Fig. 9.



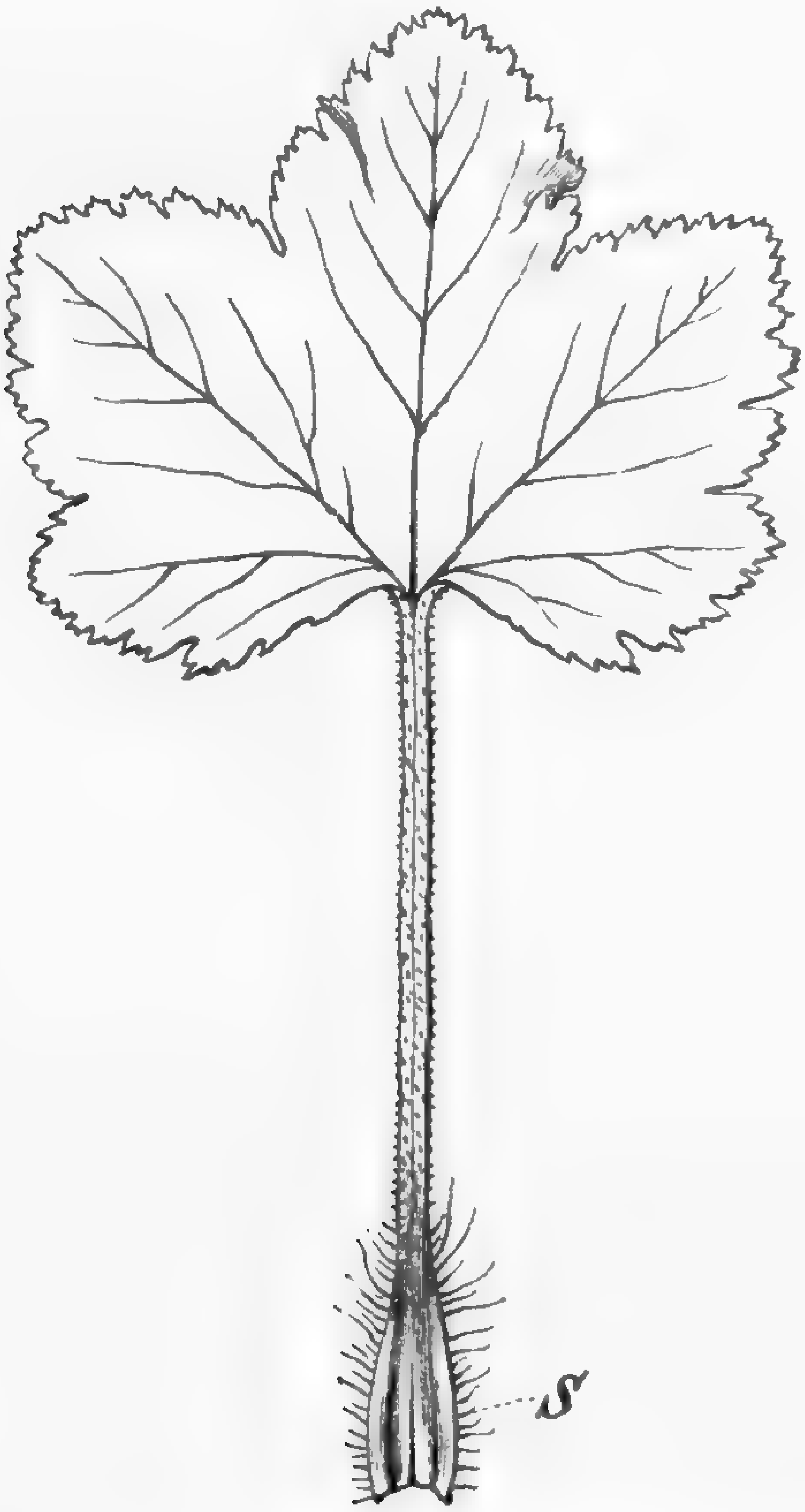
Ribes sanguineum.—Leaf higher up on shoot. *S.* Stipule.

Ribes.—In *R. sanguineum* about five (more or less) of the scales of the winter-bud are ovate, acute, 3-nerved, rather membranous, and consist of the dilated base of the petiole, the lamina being represented by a small black point. One or two suc-

ceeding ones bear a small lamina sessile on the sheath, which is wholly adnate to the thin dilated base of the petiole and membranous, especially outside of the three vascular bundles. One or two of the leaves succeeding this have a well-developed lamina, and the *sheaths* partly separated from the petiole and corresponding to *stipules*. The stipular sheaths on succeeding leaves are shorter and wholly adnate to the petiole, strongly fringed on the margin, with the hairs on the upper portion longest and more or less branching.

This series is shown in figs. 8–10.

Fig. 10.



Ribes sanguineum.—A third stage, showing stipules reduced to an adnate sheath, *S*.

I now pass to the—

Species without Stipules.

Saxifraga rotundifolia.—This species has very large sheaths at the base of the petioles. They may be considered as repre-

senting stipules, but are entirely adnate to the petiole. They completely envelop the younger leaf.

Saxifraga crassifolia.—The petiole is expanded at the base, forming a large, triangular, elongated sheath. The sides of the sheath are connate, forming a hood, by which the winter-bud is effectually protected. *S. cordifolia, S. ligulata, S. ciliata, S. Stracheyi, S. Milesii,* &c., agree in these respects.

S. Aizoon.—In the species belonging to this type the leaves are arranged in dense rosettes, except on the stoloniferous shoots, and the buds are protected by the crowd of leaves forming the rosette. On the stoloniferous shoots the leaves are semi-amplexicaul.

S. Camposii.—In this type the petioles are dilated at the base. The leaves also are arranged in dense rosettes during winter.

S. juniperifolia.—In this species the leaves are narrowly lanceolate, or subulate-lanceolate, acute, widest above the base, but slightly narrowed just there, ciliate along the edge but not membranous. There is no sheath or stipules of any kind; but the winter-bud is amply protected by the compact and dense arrangement of the leaves.

Others agreeing in the dense arrangement of the leaves are *S. sancta, S. Burseriana, S. aspera, S. aretioides, S. luteo-purpurea,* and *S. oppositifolia* with its allies, also *S. retusa.*

S. tricuspidata.—The leaves in this type are spathulate, tricuspidate, sessile, tapering slightly to a broad base, ciliate, arranged in moderately dense rosettes, while the innermost ones form a close bud.

Escallonia floribunda.—The leaves are oblong lanceolate, finely serrulate, gradually tapering into a very short petiole, glabrous, evergreen. In the bud state the petioles are concave and clasp round half of the bud at the very base, while the leaf upwards encloses the whole of the younger leaves. The arrangement is on the $\frac{2}{5}$ plan, and at the very base only two or three petioles are required to cover the whole bud at the very base, which is the widest part.

E. punctata.—The leaves are elliptic, serrate, evergreen, densely punctate beneath with glands, and slightly hairy on the midrib, very shortly petiolate. The winter-buds are covered externally by a few leaves reduced to small, ovate, green, and quite sessile structures. Those that succeed are very shortly petiolate, with broadish concave petioles wrapped partly round the bud. The

glands on the underside of the leaf supply a gummy secretion, fastening the young leaves together.

Escallonia illinita.—Here again the leaves are lanceolate-elliptic, undulate, dentate-serrulate, thinly glandular beneath, evergreen, slightly downy on both sides of the midrib. The winter-bud is protected by reduced leaves, the petioles of which are slightly dilated and amplexicaul at the very base. The leaves in the interior of an advancing bud, even in winter, are seen to be rolled round the younger ones, and their petioles are very short, dilated, concave, clasping the bud so that two or three of them completely surround it. The short petioles are furnished with fleshy glands at their edges, and these together with those on the back of the leaf supply a gummy secretion for the protection of the bud.

In other types of this family which have no stipules, as, for instance, in *Francoa appendiculata*, *Schizophragma hydrangeoides*, *Deutzia gracilis*, *Carpenteria californica*, *Hydrangea*, &c., the petioles are more or less dilated, channelled, and sheathing, so as to protect the buds.

Decumaria barbara.—The petioles are semiterete, but the bases are dilated, triangular, concave, and amply protect the buds.

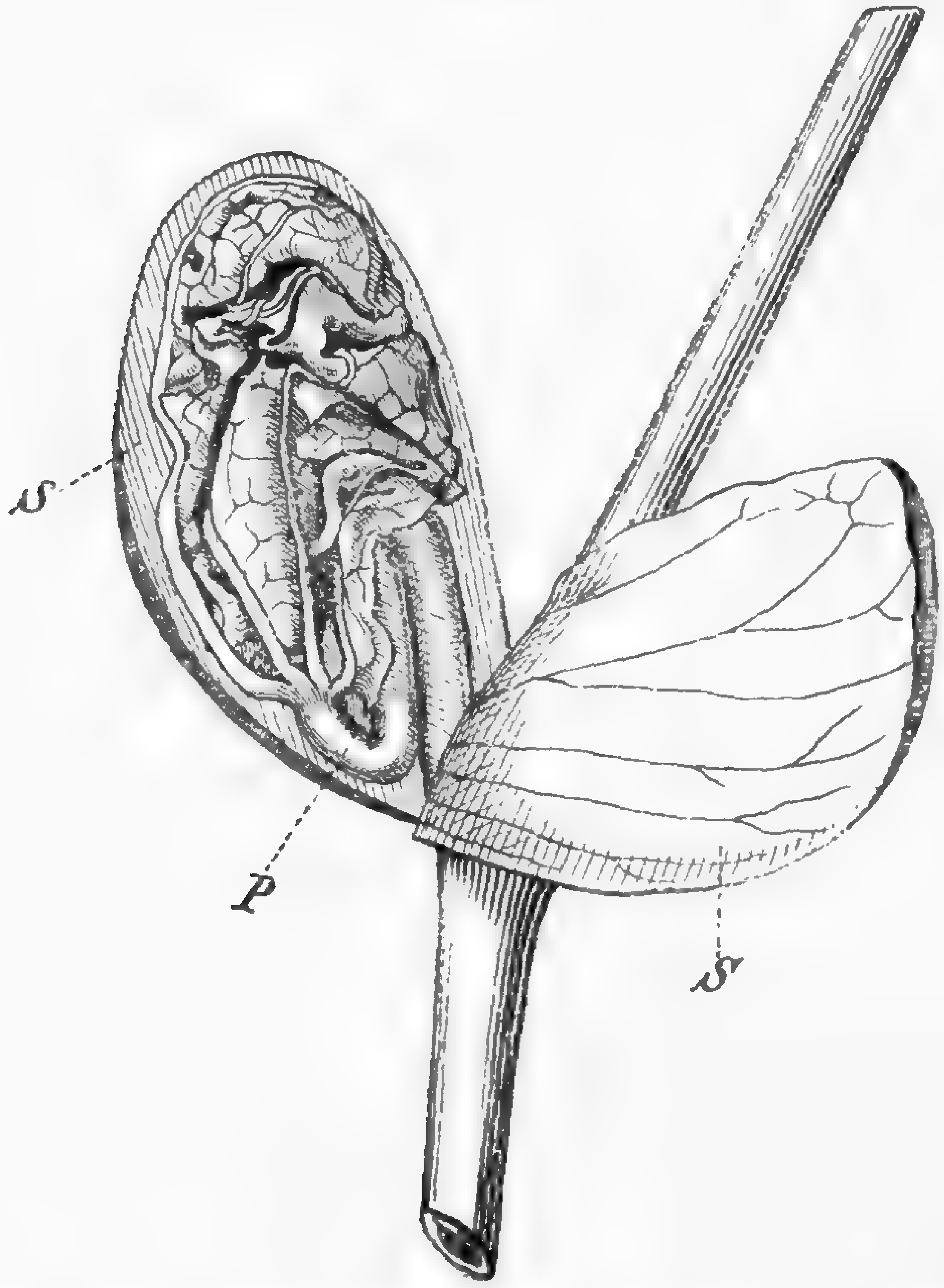
HAMAMELIDEÆ.

Bucklandia (*B. populnea*).—The leaves are large, rotund-ovate, or subcordate, suddenly acuminate with long slender point, radiately 5–7-nerved from the base, entire with a cartilaginous margin, or 3-fid near the apex, owing to the first strong nerve on either side of the midrib running out into a point, leathery, glabrous, shining above, reticulate beneath with the main nerves, and the petiole red, simple, alternate, stipulate.

The stipules are large, persistent (fig. 11), oval, obtuse, unequal-sided, with 2–3 parallel nerves on the side towards the petiole, and 4–5 on the side away from the petiole, leathery and glabrous. The two stipules cohere by their edges and form an almond-shaped box, in which the following leaves are enclosed. Within each pair of stipules one leaf is much more advanced than those which follow. It is conduplicate, attains a considerable size before emerging from the stipules, and is much folded both longitudinally and transversely. The petiole also elongates greatly and becomes twice folded or bent, as shown in fig. 11,

so that the leaf remains erect. This case is, so far as I know, unique.

Fig. 11.



Shoot of *Bucklandia populnea.*—*S, S.* Stipules. *P.* Petiole.

Myrtaceæ.

In the Myrtaceæ, again, we have cases of glandular stipules. In *Psidium Cattleyanum* they consist of 1–4 subulate processes, or of one rather membranous and colourless, trifid, or tridentate piece. They scarcely seem to be protective, but the outer process is generally tipped with a globule of fluid.

Lythrarieæ.

Punica Granatum.—Here also we find glandular stipules. The stipular processes are of two kinds—intrapetiolar glandular processes, of which those on the outer edge of the petiole are the largest; and secondly the triangular-subulate obtuse prolongations of the wings of the stems.

Lafoensia microphylla.—Here, again, the stems are quadrangular or narrowly winged, apparently from the leaves being decurrent.

The wings terminate at the upper ends in stipuliform processes, which are subulate, falcate, incurved, and about equal in length to the petioles. Besides these processes there are also numerous filamentous intrapetiolar processes, which stand erect, closely surrounding the axis. These may be protective. There are also some intrapetiolar glands.

Lagerstrœmia indica has also wings to the stems which terminate in stipuliform appendages. On the pedestal a little to the inner side of the stipules are a pair of conical glands; they are pale green when young, excrete small globules of matter, and then turn black soon after the leaves are full-grown.

Lythrum (*L. Salicaria*) has similar stipular processes at the summit of the wings; they are quite minute.

Onagrarieæ.

Fuchsia (*F. excortica*) has short, subulate or conical, fleshy stipules, which serve to protect the buds. The petioles are subterete.

Passifloreæ.

Passiflora racemosa.—The leaves are palmately 5-nerved and 3-lobed, slightly peltate at the base, conduplicate in bud, petiolate, stipulate; the petioles are terete, slightly flattening on the upper side, and with two glands below the middle, about $1\frac{1}{4}$ in. long. The stipules are large, foliaceous, obliquely ovate, obsoletely dentate on the side away from the petiole, erect and clasping the stem. In the bud stage the stipules are developed far in advance of their own leaves, so that each pair enclose their own leaf, the simple tendril in its axil, and the younger portion of the bud. Proceeding from the outside inwards, the stipules change considerably, being first ovate, gradually becoming smaller, then lanceolate, and finally subulate. In the other species of *Passiflora* examined, the stipules more or less completely protect the bud, and the petioles are terete, provided with glands.

Umbelliferæ.

The Umbelliferæ very commonly have sheathing-petioles, effectually protecting the bud. Among English genera this is the case with *Astrantia*, *Apium*, *Helosciadium*, *Sison*, *Petroselinum*, *Trinia*, *Ægopodium*, *Carum*, *Sium*, *Pimpinella*, *Œnanthe*, *Æthusa*, *Fœniculum*, *Seseli*, *Ligusticum*, *Silaus*, *Meum*, *Angelica*, *Peucedanum*, *Pastinaca*, &c. The marginal membranes of the

sheaths may perhaps be regarded as adnate stipules, and the tips are often more or less free.

ARALIACEÆ.

In the Ivy (*Hedera*) stipules are present, but small. In conjunction with the dilated and amplexicaul bases of the petioles they cover the young leaf. The winter-buds are protected by scales, consisting of the base of the petiole with its stipules.

In *Acanthopanax* (*A. spinosum*) the stipules consist of a narrow, membranous, colourless margin to the petiole, and this is cut up into brown fringes. The winter-bud is protected by scales as in *Hedera*. The petioles are subterete. In *Helwingia* also the stipules are filamentous, often irregularly laciniate.

CORNACEÆ.

In *Griselinia* (*G. lucida*) the stipules form an intrapetiolar sheath, somewhat resembling the ligule of grasses. The petiole is subterete, or slightly dilated at the base.

CAPRIFOLIACEÆ.

I have dealt with the interesting stipuliform appendages of *Viburnum Opulus* and some of its congeners in a separate paper (*infra*, p. 244). In *Sambucus* also (*S. nigra*) the stipuliform appendages are semiterete, and glandular at the tip. The winter-bud is protected by scales.

APOCYNACEÆ.

The Apocynaceæ are generally described as exstipulate, but *Strophanthus* (*S. dichotoma*) has rather large stipular processes. The petioles are slightly grooved above, united by a ridge crossing the stem horizontally, which appears to form a small socket into which the next joint of the axis fits. Within the petioles this ridge is continued and becomes there drawn out into a triangular acute stipuliform process. The function of these intrapetiolar processes is evident on examination of the terminal bud which they protect in the early stages, gradually opening as by two valves. The next younger pair of leaves decussating with those bearing the stipular processes have their sides protected for some time by the latter, their stout midribs becoming first exposed. The stipular processes are persistent and ultimately become brown.

Platanaceæ.

The case of *Platanus* is very interesting. The winter-buds are covered by a number of cap-like stipules, the leaves belonging to which have become completely aborted. The outer stipule or cup is brown or reddish brown and secretes a gummy substance on its inner surface, besmearing the bud as in the Horse-chestnut, but only in the very early stages. As the bud swells the outer cap becomes ruptured and appears then like a deeply concave scale, which is glabrous or nearly so. This is followed by others which attain a larger size before the expanding bud causes them to split; they are densely covered with brown hairs externally and glabrous internally.

Dipsaceæ.

In the Teasel (*Dipsacus*) the bases of the petioles are expanded and connate, thus forming a large cup, which generally contains water. It has been suggested by Kerner that this water forms a sort of moat which protects the flowers from ants and other creeping insects. On the other hand, Mr. Francis Darwin thinks that insects &c. are drowned in the water, and thus supply the plant with animal food. He has described certain curious protoplasmic threads, emitted by some of the cells, which he suggests may serve to absorb the nourishment thus supplied.

Urticaceæ.

In the Hop (*Humulus Lupulus*) the stipules are intrapetiolar, connate for $\frac{2}{3}$ or $\frac{3}{4}$ of their length; each pair forming an ovate 10-nerved piece, with the tips ovate and free. These sheaths effectively surround and protect the growing axis. This type occurs in other species of climbing plants.

Conclusion.

On the whole, then, where we find in the same family or genus some species with, and some without, stipules, I believe that as a general rule this difference has reference to the mode of protection of the bud. This important function is effected in various ways,—by the stipules, by the base of the leaves, by the more or less expanded base of the petiole, by the pedestal of the petiole, by scales, by hairs, by gummy secretions, &c.

The protection of the bud seems then to be the most general reason for the presence of stipules, though sometimes they take

on the function of the leaves themselves, sometimes they become spiny and serve as a general protection to the plant, sometimes they are glandular, &c.

The view here suggested seems to apply well both to the cases where the stipules are very short-lived, and also to those in which they are very persistent. When they serve, and serve only, to protect the leaves to which they themselves belong, they often fall off when the leaves themselves expand. On the other hand, there are cases where they protect the following leaf or leaves, as for instance in *Magnolia*, *Liriodendron*, and other *Magnoliaceæ.* When the stipules of the terminal leaves of one year protect the next leaves, which do not emerge till the following year, they are much more persistent than the leaves themselves. Both cases sometimes occur in the same family.

This, then, is the answer I should give to M. Vaucher's question, and the presence or absence of stipules is not determined I think, as suggested by DeCandolle, by any question of general symmetry, but rather by practical considerations connected with the wants and requirements of the plants.*

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Fig. 4. Shoot of *Leea coccinea.* *P.* Petiole of leaf, the lamina being cut off. *S.* Stipule. *L.* Young leaf emerging from stipules.
Fig. 5. Shoot of *Spartium junceum.* A. Nat. size ; B. More magnified to show the bud protected by the pedestal of the fallen leaf.
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Fig. 7 *a.* Leaf of *Nuttallia cerasiformis,* with entire sheath.
Fig. 7 *b.* Leaf of *Nuttallia cerasiformis,* higher up, showing indications of stipules
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Fig. 8 A. *Ribes sanguineum.* Outer bud-scale with 3 vascular bundles ; stipules indicated by lateral teeth at the tip.
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Fig. 10. *Ribes sanguineum.* A third stage, showing stipules reduced to an adnate sheath, *S.*
Fig. 11. Shoot of *Bucklandia populnea.* *S, S.* Stipules. *P.* Petiole.

* In the preparation of this paper I have relied mainly on the facilities afforded by Kew Gardens, and I desire to express my thanks to the late and present Directors, Sir J. Hooker and Mr. Thiselton Dyer, and indeed to the Staff generally.

On the Form of the Leaf of *Viburnum Opulus* and *V. Lantana*.

By the Rt. Hon. Sir JOHN LUBBOCK, Bart., M.P., F.R.S., D.C.L., LL.D., F.L.S.

[Read 20th February, 1890.]

WE have in this country two wild species of Guelder Rose: one *Viburnum Lantana* (usually known as the Wayfaring Tree); the other *Viburnum Opulus*. They frequent woods, especially in chalky districts; but, though very nearly allied, their leaves are remarkably different. I extract the following descriptions from Syme*:—

Of *V. Opulus* he says:—"Leaves deciduous, stalked, roundish in outline, 3-lobed, with the lobes acuminate, coarsely toothed and ciliated, finely pubescent, but not furfuraceous beneath. Petioles with adnate stipuliform appendages in the form of 1 (or sometimes 2) linear processes on each side a little above the base." There are, I may add, two or more honey-glands at the base of the lamina of the leaf.

Of *V. Lantana* he says:—"Leaves very shortly stalked, without stipules, ovate-oval or elliptical-oval, dentate-serrulate, deciduous, rugose, furfuraceous-pubescent beneath, especially on the veins, at length nearly glabrous." There are no honey-glands.

No attempt, so far as I know, has been made to account for the difference in form of the leaf in species so nearly allied; for the presence of the honey-glands in the one and not in the other: nor to explain the reason for the existence of the peculiar filiform stipuliform appendages; nothing exactly resembling which occurs in any of our other forest trees, the nearest approach being in the allied genus *Sambucus*. The presence of stipules in *Viburnum* would be the more remarkable, as in the family Caprifoliaceæ, to which the Viburnums belong, stipules (if they be stipules) are confined to this genus, to *Pentapyxis* and to *Sambucus*.

There are many cases where, among allied species, some have stipules and others have not. Thus among the Alsineæ stipules are present in *Spergula* and *Spergularia*, and amongst the Polycarpeæ, while *Alsine*, *Stellaria*, *Cerastium*, and others have none.

* In Sowerby's 'English Botany,' 3rd ed. iv. pp. 202 and 203.

In other cases, even in the same genus, this difference occurs. Thus in *Helianthemum*, *H. œlandicum* and *H. canum* have no stipules, while *H. vulgare* has. I do not know that any explanation has been suggested to account for these differences, with which I have attempted to deal in the previous paper (*ante*, p. 217).

According to DeCandolle's 'Prodromus,' there are 41 species of *Viburnum*, and though some more must now be added, this would not materially affect the question. Of these 41, 35 have the leaves entire, and more or less resembling those of *V. Lantana*. None of these possess stipules. The other six have lobed leaves, more or less like those of *V. Opulus*, and these all have stipuliform appendages, the existence of which would seem, therefore, to be connected with the presence of the lobes.

The existence of honey-glands at the base of the leaf is also, perhaps, connected with the texture of the leaf.

In *V. Lantana* the covering of felted hairs affords a sufficient protection; but the tender young leaves of *V. Opulus* would afford a tempting food to many caterpillars and other insects. The ants and wasps which are attracted by the honey would tend to keep them down, and thus to serve as a body-guard. Indeed, it appears to be the case that on specimens of *V. Opulus* which are much frequented by wasps and ants, the leaves are less eaten than in other cases where they are not so protected.

I now come to the stipuliform appendages. These often bear honey-glands, but by no means always, and even where these occur there seems no reason why they should be situated on filiform appendages. On the whole, then, I doubt whether they can be explained as mere honey-glands, or whether, indeed, they are of any actual use when the leaves are fully developed.

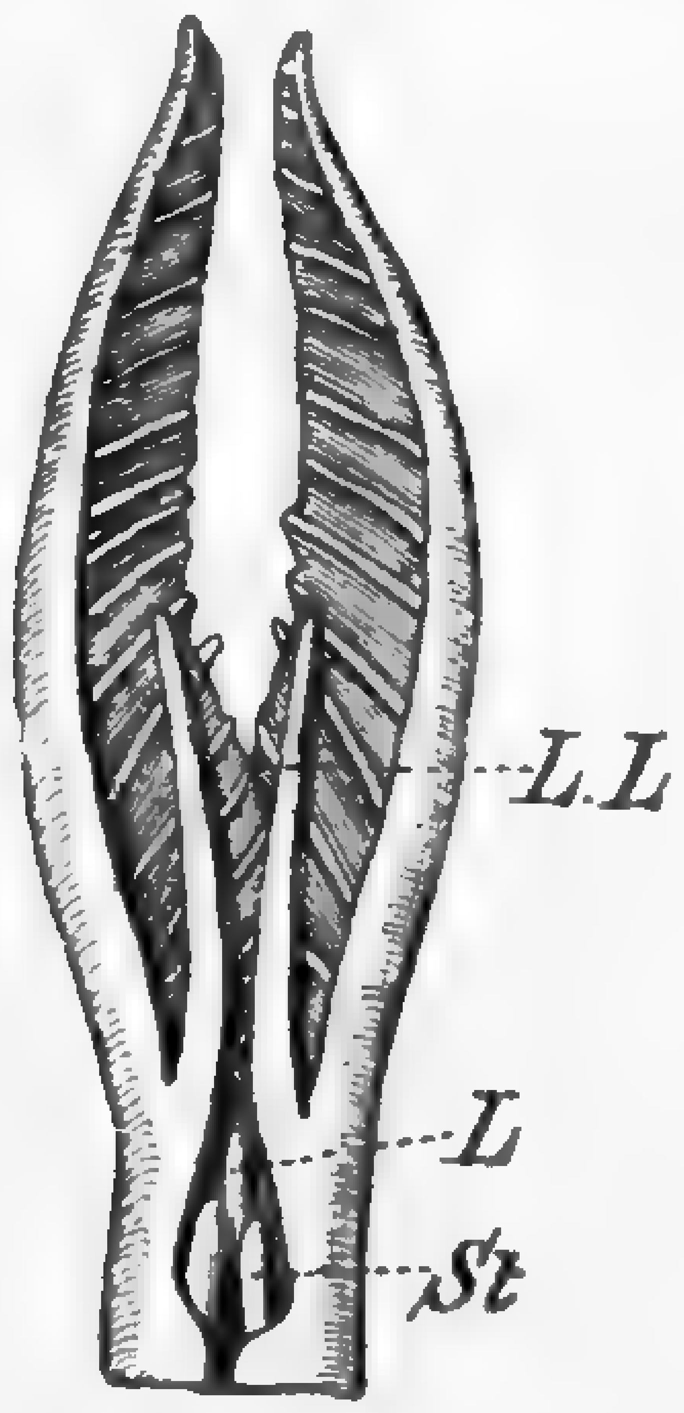
When we meet with a small organ which appears to have no definite function, we naturally ask ourselves whether it is the disappearing relic of some larger organ which at one time performed some useful purpose in the economy of the animal or plant. This suggestion, however, seems untenable in the present case, because, as a matter of fact, we do not find that the stipuliform appendages are more developed in any of the species allied to *V. Opulus*.

There is, however, a physical cause to which perhaps the presence of these organs may be due. We have seen that much the larger number of species of *Viburnum* have entire

leaves, more or less oval or ovate. This would appear to be the form typical or original to the genus.

Now let us suppose that, either from having extended northwards (and both *Viburnum Lantana* and *V. Opulus* are among the northern representatives of the genus), or from some other cause, the young leaves require additional protection. This may be effected in several ways. For instance, the young leaf may be guarded by a thick coat of felted hairs: this is the case in *V. Lantana*. Another plan would be that the outer leaves should become leathery and thus protect the inner ones: this is the case with *V. Opulus*. But that being so, it is an advantage that the inner or true leaves should be folded, because they thus occupy less space. This perhaps accounts for the folding of the leaves of *V. Opulus* in the bud, while the lobes follow from the mode in which the leaves are folded. Now a leaf folded up as are those of *V. Opulus* requires only two or three lateral veins. The remaining veins, then, and the membrane connecting them, will gradually be reduced, and ultimately disappear.

In *V. Opulus*, as is shown in the figure, there is a space left



Viburnum Opulus. Bud, × 4.—*L.L*, lateral lobes of leaf; *L*, one of next younger pair of leaves; *St*, stipule.

between the bases of the leaves. In the Acers, many species of which have leaves somewhat resembling those of *V. Opulus*, this space is fully occupied by the following pair of leaves. This, however, is not the case in *V. Opulus*, and the space thus left unoccupied is filled up by the stipuliform appendages. I

may also observe that the stipuliform appendages also resemble leaf-lobes in being slightly conduplicate.

These considerations seem to throw some light on the differences between the leaves of *Viburnum Lantana* and *V. Opulus*, the hairiness of the former and the smoothness of *V. Opulus*, on the lobed form of the leaf in the latter, and, lastly, on the presence of the honey-glands and the peculiar stipuliform appendages in *V. Opulus*, neither of which occur in *V. Lantana*.

In support of the above suggestions, I may refer to the very interesting analogy afforded—in a totally different family—by the genus *Spiræa*. Here we find some species with entire, some with pinnate, leaves, while those of *S. opulifolia*, as the name denotes, closely resemble those of *Viburnum Opulus*. Now the entire-leaved species of *Spiræa*, like those of *Viburnum*, have no stipules; while *S. opulifolia* agrees with *Viburnum Opulus* not only in the shape of the leaves, but in the mode of folding in the bud, and also in the presence of subulate, acuminate, stipuliform appendages.

On the Fruit and Seed of the Juglandeæ. By the Rt. Hon. Sir JOHN LUBBOCK, Bart., M.P., F.R.S., D.C.L., LL.D., F.L.S.

[Read 20th February, 1890.]

PTEROCARYA.

IN a previous memoir I have figured the mature seed and seedling of *Pterocarya caucasica* (Journ. Linn. Soc., Bot. vol. xxii. pp. 359 & 386). They are very peculiar, and it may be interesting to describe some of the earlier stages in the development of the fruit. I have to thank Mr. Lynch for his kindness in keeping me supplied with specimens of the fruit in its various stages from the tree in the Cambridge Botanic Gardens. It will be remembered that the seed (Journ. Linn. Soc., Bot. vol. xxii. p. 386, fig. 118) is shaped somewhat like an anvil, with four short, wide legs; and that the seedling is characterized by having the cotyledons bifid, each division being again bilobed.

Pterocarya caucasica flowers with us early in May. The

pistil is inferior, syncarpous; the ovary of two carpels, one-celled, one-ovuled; the ovule basal, erect, and orthotropous.

Fig. 1.

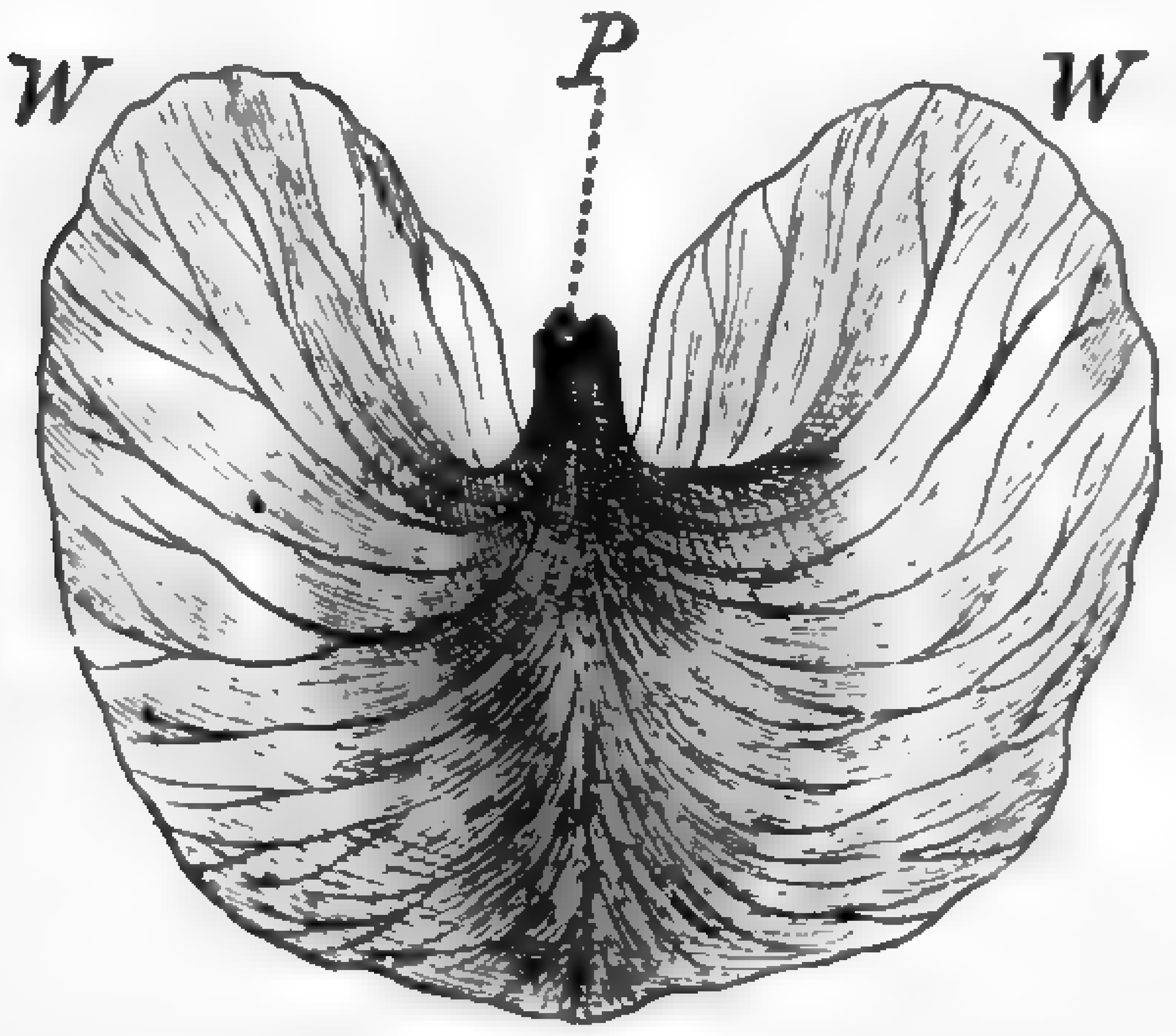


Fig. 1 *a.*

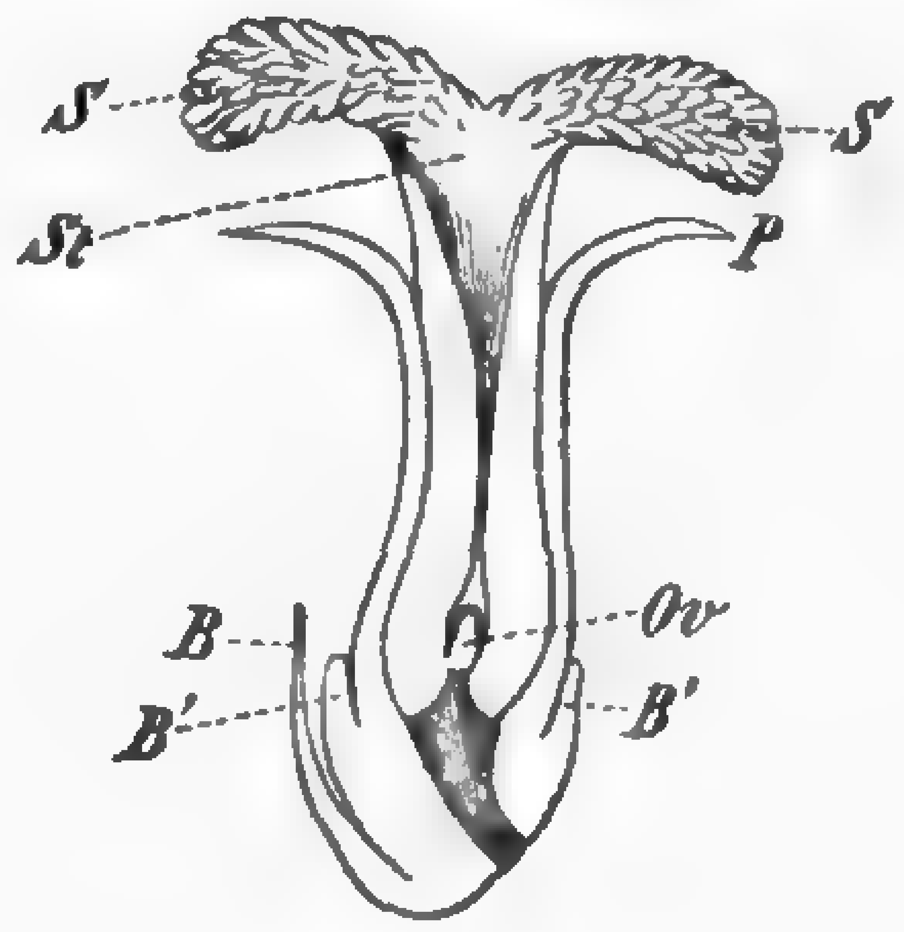
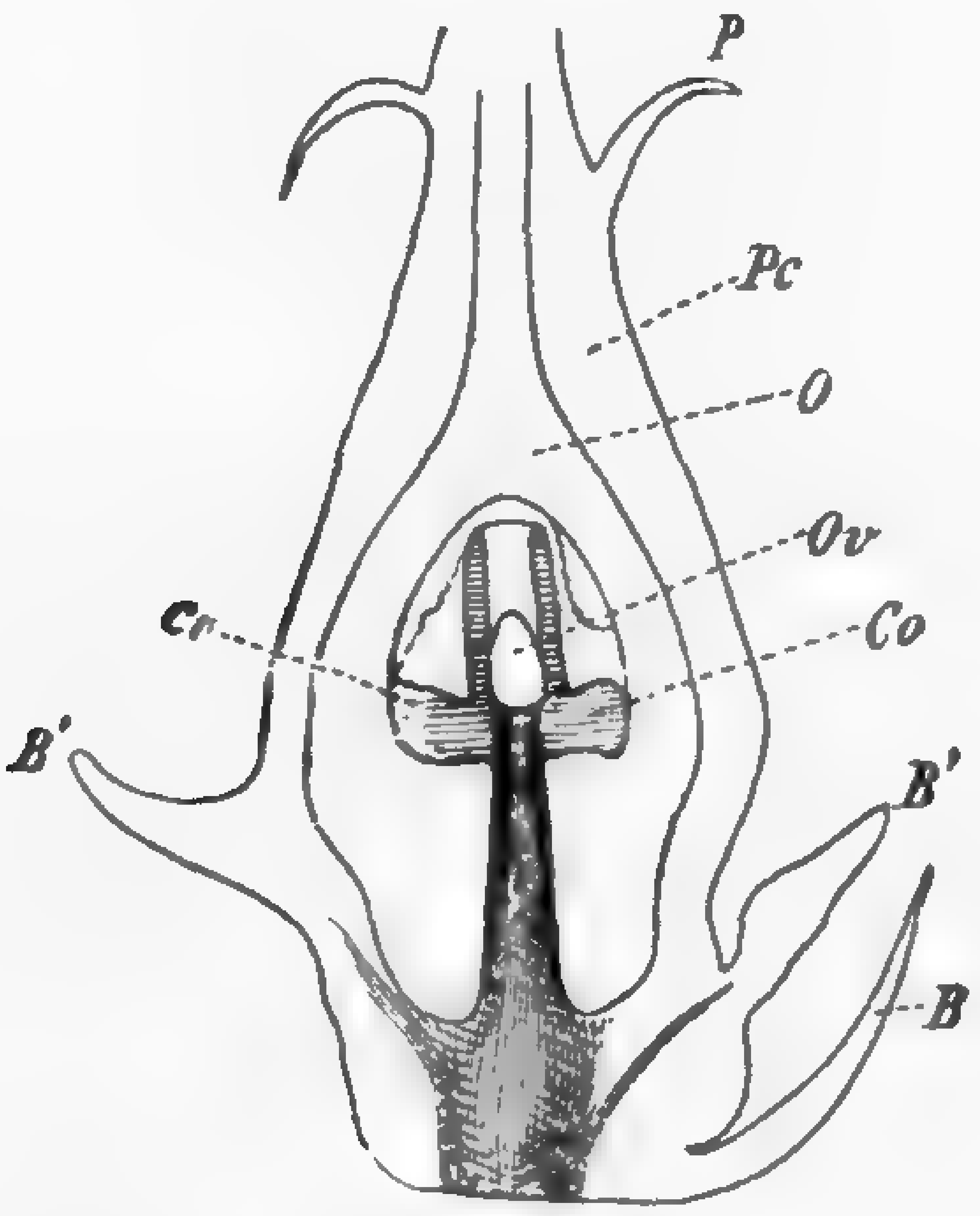


Fig. 1. Fruit of *Pterocarya.* ×2.—*P*, perianth; *W*, *W*, wings.

Fig. 1 *a.* Section through the flower of *Pterocarya Caucasica.* ×6.—*B*, bract; *B'*, *B'*, bracteoles; *Ov*, ovule; *P*, perianth; *St*, style; *S*, *S*, stigmas. 23rd May.

Fig. 1*a* is a section through the young flower at the end of May, showing a bract *B* at the base, two bracteoles *B' B'* at the sides, the ovule *Ov*, perianth *P*, and *S S* the two large, spreading, papillose stigmas. The cavity of the ovary is small and nearly filled by the ovule.

Fig. 2



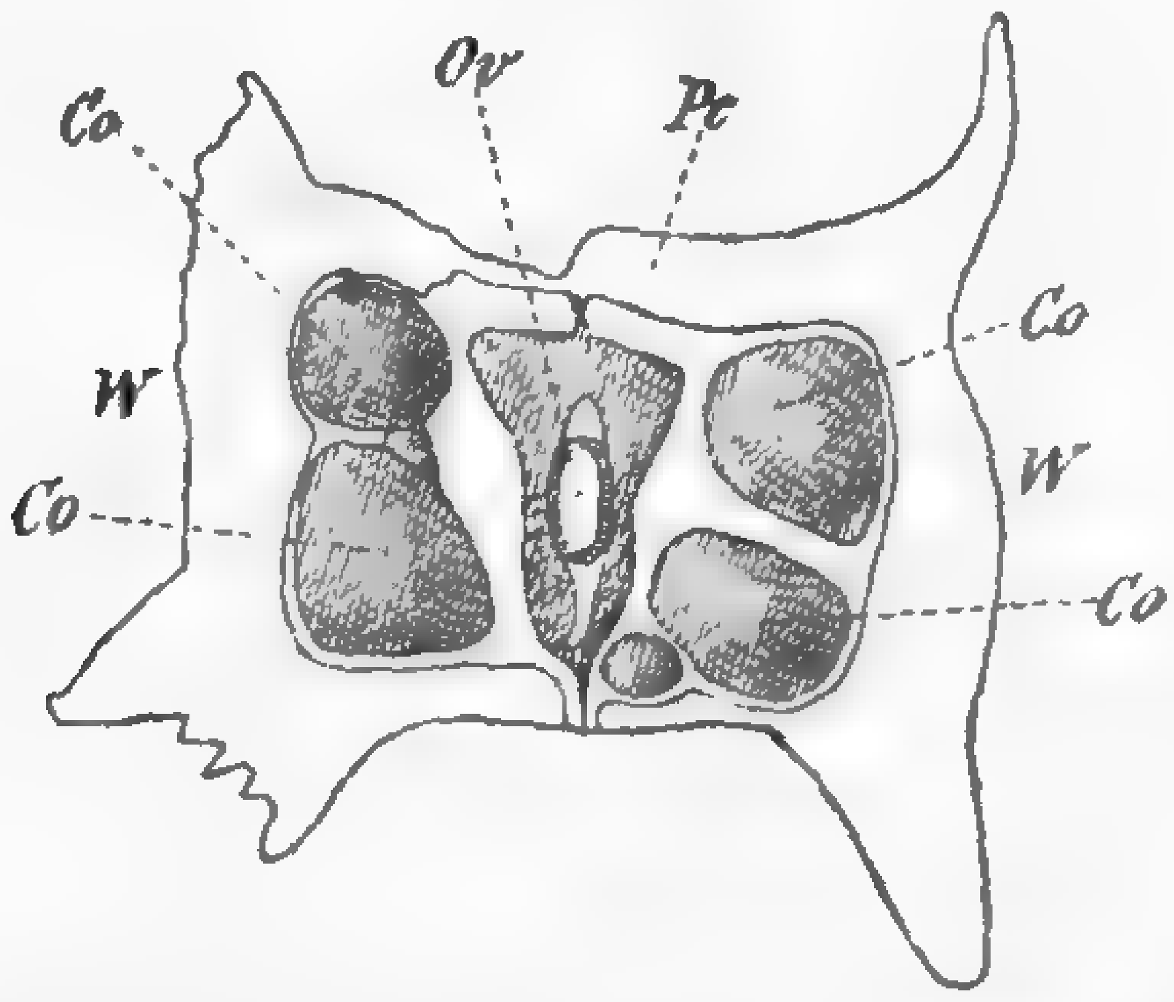
Section of Fruit. June 25. ×6.
Co, *Co*, two places where the tissue has become colourless.

By about the middle of June the young fruit had grown considerably in thickness, though not much in length. The ovary and ovule are longer, and at the base of the former the tissue has in two places (fig. 2, *Co*, *Co*) become almost colourless from the removal of the protoplasm.

By the end of June the fruit has still further increased in length as well as in breadth. The growth in length has especially taken place between the base and the uppermost point of attachment of the bracteoles, which therefore seem to have been carried up. They have also increased in size, while the perianth remains unaltered. The two masses of colourless tissue as seen in longitudinal section at the base of the ovary are still solid or unbroken.

The fruit continues to grow rapidly, especially at the base, so that by the end of July the posterior half of the bracteoles seems to be carried still further up, distinctly more so than the anterior.

Fig. 3.



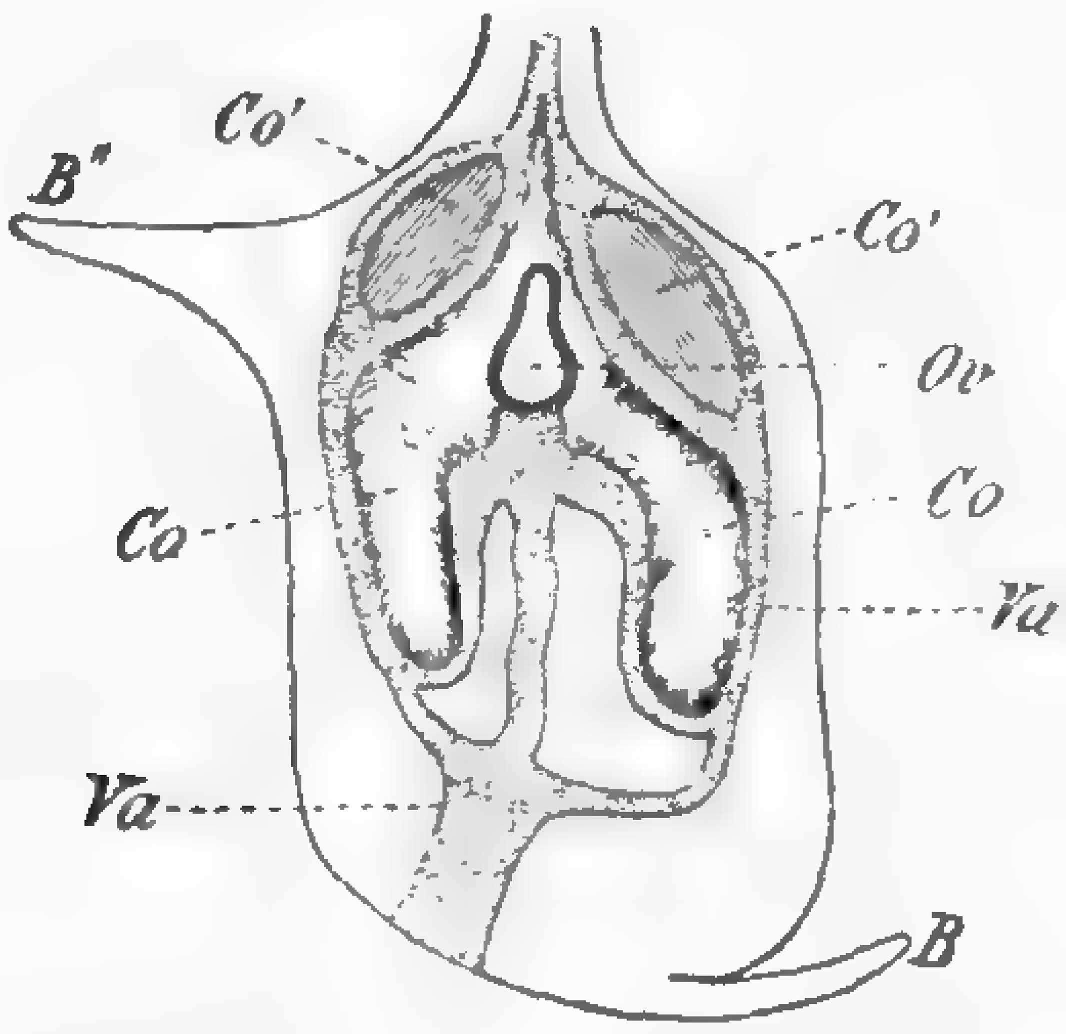
Transverse section of Fruit. ×3.—*W*, *W*, wings; *Pc*, pericarp; *Co*, *Co*, *Co*, *Co*, four spaces of altered tissue; *Ov*, ovule.

The neck of the fruit, on the contrary, has increased considerably in thickness, but scarcely at all in length. Fig. 3 represents a transverse section, and on each side of the ovule (*Co*, *Co*, *Co*, *Co*) are the four approximately circular patches of colourless tissue, which in a longitudinal section appear more elongated. In them the tissue is commencing to disintegrate, while round them, on the contrary, it is becoming distinctly sclerenchymatous. From the development of the lower part of the fruit especially on the posterior side, the posterior portion of each bracteole appears to be nearly on the summit of the fruit, the anterior portion being rather lower down.

Fig. 4 is a longitudinal section taken on the 8th August. It passes through two of the masses of loose tissue mentioned above, and which now form cavities; while, on the other hand, the surrounding tissues have become much denser, leaving, however, oval spaces of cortical tissue shown in section at *Co'*, *Co'*.

The ovary has not materially altered, and the ovule is still very small.

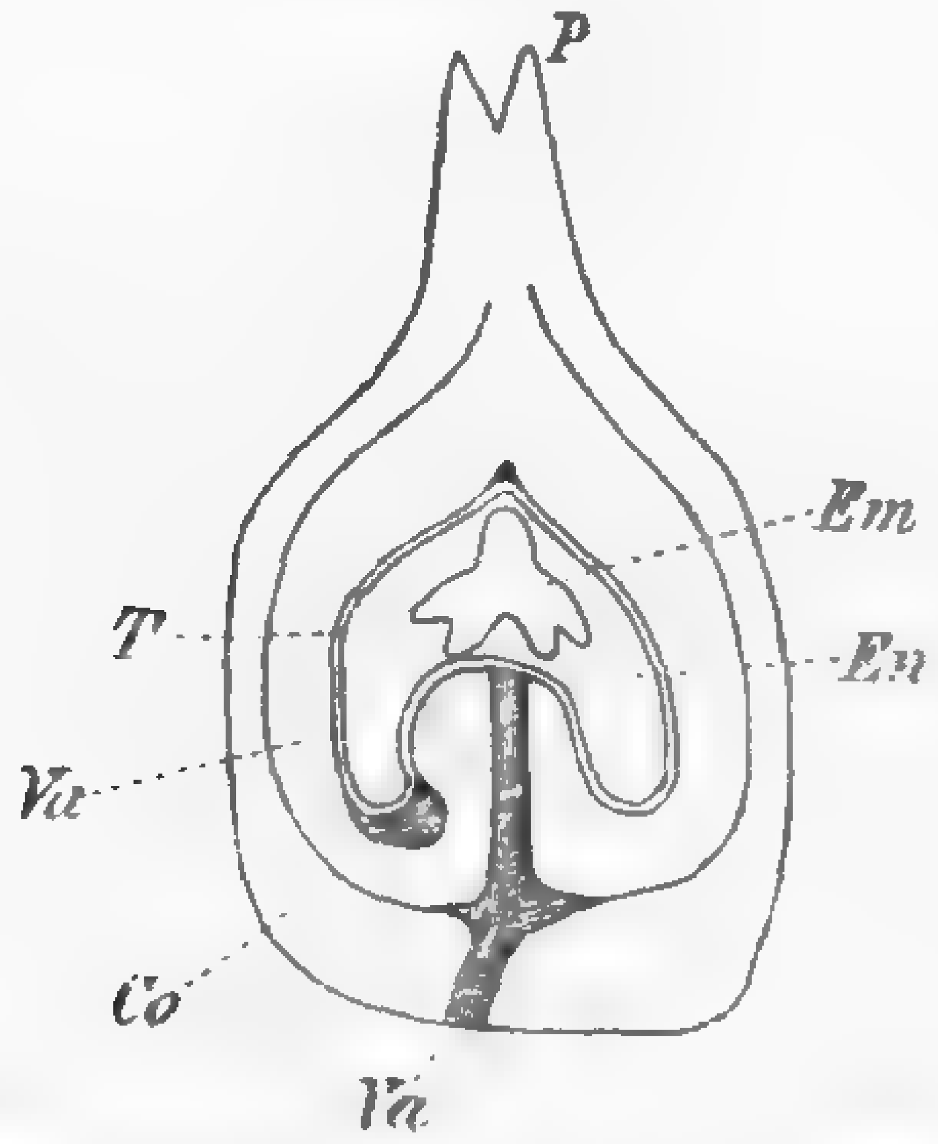
Fig. 4.



×3. *Va, Va,* vascular tissue; *Co', Co',* masses of solid tissue; *Co, Co,* cavities.

A few days later, however, it has grown considerably and nearly fills the cavities. Fig. 5 shows a longitudinal section

Fig. 5.



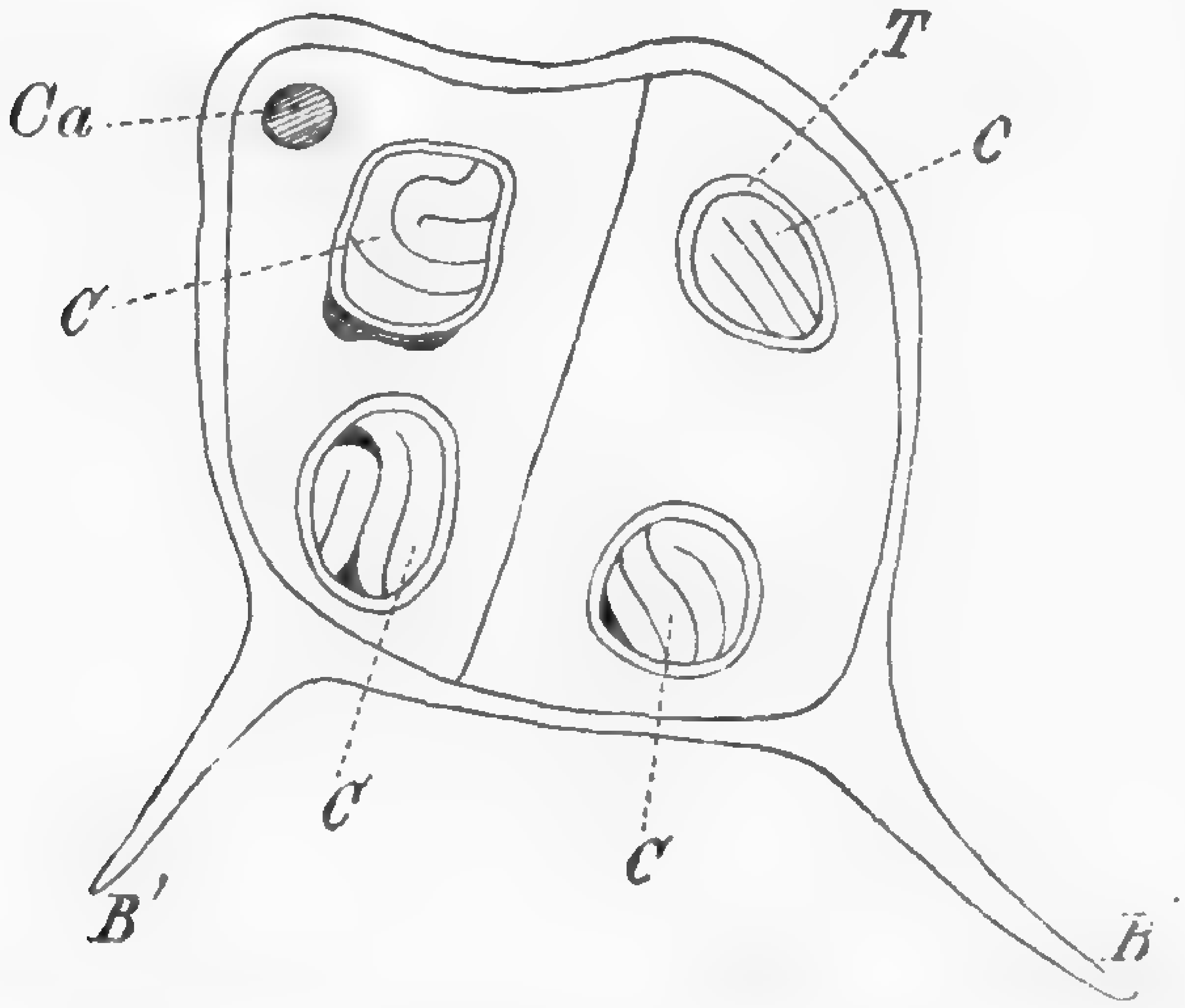
Longitudinal section of more advanced fruit. Sept. 1. ×3.—*T*, testa; *En*, endosperm; *Em*, embryo; *P*, perianth; *Va*, vascular tissue; *Co*, small cavity not yet filled by the seed.

taken on the 1st September. *T* is the testa, showing that the seed has now assumed its four-lobed form, though it has not yet quite filled the cavities in the fruit. The greater part, however, is occupied by endosperm, the embryo (*Em*) being still comparatively small.

Fig. 6 represents a transverse section near the base of the fruit, taken on the 21st September, when the fruit and embryo had attained nearly their full size, but had not yet reached maturity. Neither the placenta nor the original and true cavity

of the ovary are shown in this section, because they were situated at a higher level. The ovule from the first was basal, and the seed, even at maturity, may be looked upon as lying astride the basal placenta, with its four lobes projecting into as many cavities excavated from the originally solid base of the fruit.

Fig. 6.



Transverse section through a more advanced fruit near the base. ×6. Sept. 21.—*T*, testa; *C*, *C*, *C*, *C*, folds of cotyledons; *B'*, *B'*, bracteoles or wings; *Ca*, small mass of cortical tissue.

The testa is shown at *T*, lining the interior of the cavities and enclosing the variously folded lobes of the cotyledons (*C*, *C*, *C*, *C*). The walls surrounding the cavities are thick and sclerenchymatous, with exception of the thin outer rind and its appendages, the bracteoles or wings, shown at *B'*, *B'*. The cotyledons of the embryo diverge, one to each side of the fruit, and their lobes pass in pairs into each of the four cavities of the fruit. As growth proceeds and the short lobes become too wide for the cavities, they become conduplicated in order to accommodate themselves to the restricted space and at the same time to fill it. The secondary fission seems intended to facilitate folding, and was probably originally brought about by excessive plication. If the two lobes had been in one piece, the latter would have had to be twice conduplicate longitudinally, which would have been difficult to accomplish. The folding is not always on the same plan, as may be seen by reference to the figure.

THE WALNUT (*Juglans*).

The fruit of the Walnut differs from that of *Pterocarya* in several remarkable particulars, and while the cotyledons of *Pterocarya* are leaf-like and aerial in germination, those of the Walnut never emerge from the seed.

Chabræus long ago remarked on the wonderful richness of nature as displayed in the Walnut, "præsertim miranda figuræ luxuria naturam in hoc fructu lusisse certum est." The Walnut, from its fancied resemblance to a head, the outer woody covering being compared to the skull, and the folds of the cotyledons to the convolutions of the brain, was formerly supposed to be especially efficacious in brain-disease.

In the Walnut (*Juglans regia*) the ovary is one-celled or imperfectly four-celled, one-ovuled; the ovule is erect and orthotropous, with the micropyle superior. The fruit is drupaceous, oblong-globose, crowned with a small point consisting of a 3–5-toothed involucre formed by the union of the bract and bracteoles, by the remains of the 4-toothed perianth and the remains of the style; exocarp or rind smooth, and beset with submerged glandular dots bursting irregularly when mature, subfleshy; endocarp hard or bony, and brittle unless very thick, corrugated externally, with large irregular corrugations internally, and apparently excavated into four large cavities at the base; and if so, the excavations are continued to the top of the main cavity of the ovary, hollowing out the sides of the endocarp so as to furnish a larger amount of space for the seed than is originally provided for it. In Bentham and Hooker's 'Genera Plantarum' the base of the endocarp is said to be intruded, imperfectly dividing the fruit into 2 or 4 loculi. The endocarp further consists of two valves or halves, which are, however, indehiscent.

The seed is large, strongly and irregularly corrugated, seated on the central and originally basal placenta, which in the mature fruit is about $\frac{1}{3}$ above the base of the cavity of the endocarp, deeply 4-lobed at the base and filling the four cavities; the testa is thin, closely applied to the corrugations of the endocarp externally before the seed becomes dried up, and internally to the lobes of the embryo, pale brown.

In the young state the endosperm fills the interior of the seed with a clear jelly-like mass, on the top of which is the small

embryo, with the radicle close to the apex. Gradually, however, the cotyledons grow and eventually absorb the whole of the endosperm, thus filling the whole of the interior of the seed, except, of course, the small portion occupied by the plumule and radicle.

We have seen that in the fruit of *Pterocarya* four hollow spaces gradually form themselves in the originally solid fruit, and that into these spaces the seed sends four prolongations, into which again the cotyledons subsequently grow. Now in the Walnut a very similar process takes place, only the hollow spaces are much larger and confluent with the ovary-cavity, so that instead of a solid wall with hollow spaces occupied by the seed, it gives the impression as if the seed was thrown into folds occupied by the wall of the fruit. To occupy these spaces fully, the cotyledons themselves were thrown into folds as we now see them. The fruit of *Pterocarya* is much smaller than that of the Horse-chestnut, which doubtless was itself formerly not so large as it now is. As it increased, the cotyledons became fleshier and fleshier, and found it more and more difficult to make their exit from the seed, until at last they have given up any attempt to do so. Hence the curious folds, with which we are so familiar, are the efforts made by the original leafy cotyledons to occupy the interior of the nut.

Comparison of the Fruits of Pterocarya *and* Juglans.

Thus, then, while essentially similar, the fruits of *Pterocarya* and of the Walnut offer several remarkable differences. They resemble in some respects the relations between the fruits of the Hornbeam and of the Beech. The fruit of *Pterocarya,* like that of the Hornbeam, is winged, which is not the case with the Walnut or the Beech; it is in the two former smaller, and a great deal harder than in the two latter. Again, the cotyledons of *Pterocarya* are aerial, while those of *Juglans* no longer perform the functions of leaves and never quit the seed.

In the Walnut, as in some other trees, it is an advantage that the seeds should be large rather than numerous. In this way they are able to contain a supply of nutriment, which suffices rapidly to carry the young plant above the grasses and other low herbage. These seeds form the food of squirrels and other animals, which accordingly serve to disperse them, and thus perhaps they are enabled to dispense with any other means of

transport. Moreover, for such large fruits wings would perhaps be scarcely adequate.

In *Pterocarya*, on the contrary, the fruits are much smaller and wings therefore more suitable. Possessing in themselves the means of dispersal, they have no need of offering any attraction to animals. In fact every one which is eaten is so much pure loss. Hence, while the shell of the Walnut is sufficiently hard to protect the seed from the severity of the weather, and from the attacks of most insects &c., which would not help in their dispersal, it offers no obstacle to larger animals. That of *Pterocarya*, on the contrary, is very hard and strong, and even the interior portion (the walls and pillars surrounding the four hollows) are of the same character, while in the Walnut they are, comparatively, quite soft.

One reason why the similarity of construction in the two seeds does not at first strike the observer, is that in *Pterocarya* the lobes of the seed evidently enter the pericarp; in *Juglans*, on the contrary, the lobes are so much larger that it rather seems as if the pericarp sent projections into the seed.

That the present condition of the Walnut seedling is not original, we have interesting evidence in the presence of small leaves reduced to minute scales, as in the Oak and many other plants (Journ. Linn. Soc. Bot., vol. xxii. p. 360) with subterranean cotyledons.

These scales evidently indicate the former presence of actual leaves, which are now no longer required. The curious lobings and foldings of the seed in the Walnut also remind us of the time when the cotyledons were variously lobed and folded so as to occupy the whole space in the gradually enlarging seed. At present they seem to fulfil no useful function, except as a storehouse of nourishment for the seedling.

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The GENERAL INDEX to the first twenty volumes of the Journal (BOTANY) and the Botanical portions of the Proceedings from November 1838 to June 1886 is now ready for delivery to the Fellows on Application.

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NOTICE.

Vols. XXVI. and XXVIII. are in course of simultaneous issue, to expedite the publication of papers, and the Parts already published are as follows :—

Vol. XXVI. Nos. 173–175.
(Nos. 176–180 inclusive are reserved for the completion of Messrs. Forbes and Hemsley's "Index Floræ Sinensis.")

Vol. XXVII. was completed with the issue of the last Part 187–188, containing Titlepage, Contents, and Index.

Vol. XXVIII. Nos. 189–192, and 193 (the present Part)

Attention to this announcement is specially requested, to prevent application to the Librarian for unpublished Parts.

The Meetings of the Society during the remainder of the Session will be as under :—

June. Thursday, the 4th.
" " 18th.

The Chair will be taken at 8 P.M.

AUGUST 15. Price 4s.

THE JOURNAL

OF

THE LINNEAN SOCIETY.

VOL. XXVIII. BOTANY. No. 194.

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NOTE.—The Charter and Bye-Laws of the Society, as amended to the 19th March, 1891, may be had on application.

On the Vertical Range of Alpine Plants in the Caucasus. By Dr. Gustav Radde, of Tiflis.

(Communicated by Sir Joseph Hooker, K.C.S.I., F.R.S., F.L.S., and translated by the Senior Secretary of the Linnean Society.)

[Read June 19th, 1890.]

I hope by the present communication to induce ardent mountaineers, especially the English, who have of late years chosen the Caucasus as the scene of their perilous excursions, to render valuable service to Science. It is much to be desired that climbers should not neglect organic living forms in the upper alpine zones of this country, and that they should particularly observe those sporadic forms which occur here and there in the domain of perpetual ice and snow. It may certainly sound strange to speak of Phanerogams living above the snow-line, but it is nevertheless a fact. Above the snow-line there exist small, restricted areas of exceptional climatic character, from which the snow is either absent, or from which, notwithstanding their elevated position, it vanishes during the summer. These localities are either bare ridges, ribs, or precipitous rocky walls, or else they consist of chaotic heaps of stones, mostly volcanic, which have rolled down from the circumjacent expanses of ice and *névé*.

The refractive action of the rays of light and heat on such places is altogether different from that on ice and snow surfaces, and these stones possess besides an extraordinary faculty for absorbing heat. To take an instance, the porous weathered dusky trachyte, and the frequently occurring blistery, blackish lava greedily absorb the direct rays of the sun, while the surrounding coherent ice and snow strongly reflect them. In the height of summer, and towards its close, from the beginning of August to the middle of September, when the atmospheric conditions of the Armenian highlands are favourable in respect of dryness and clearness of sky, then the heat of the sun exerts unusual power. The spots mentioned as occurring in the regions of perpetual snow, not only become warmer themselves during the day, but at night also they give out a certain warmth; and it is to this economy of heat must be ascribed the fact that certain

Phanerogams not only live above the snow-line, but maintain their ground and are able to flower and mature seed. The last function is completed in a very short period, the above-ground life of the tallest is finished in five to six weeks.

It would be of the highest value for the accurate and scientific solution of such questions if continuous and relative observations of temperature were made at the altitudes under consideration. The indefatigable and adventurous Parrot ('Reise zum Ararat,' p. 187) has recorded that he passed two nights in the open air at a height of 13,036 Paris feet (13,122 English feet) on the 26–27th September, 1829, "on a shelf of rock, without fur, quite comfortably;" and thereby confirms the fact that such spots, notwithstanding their great elevation, are warmer at night than the grassy slopes lower down. I may also remark that this is according to my own experience; for instance, at one of our halting places, on the north side of Bingöl-dagh, on the 5/17–6/18 August, 1874, at about 10,000 feet altitude, where there were still to be found patches of grass, it was colder than at a much higher rocky wilderness on the sides of the crater of the extinct volcano, where in the hollows even succulent Umbelliferæ from 2 to 4 feet high were able to grow strongly. The fact being, that these hollows offered a purely local higher night temperature, by reason of the sun-heat absorbed in the daytime by the dark volcanic stone, than could be found anywhere around, except at lower elevations. Nor was it otherwise on 8/20–9/21 August, 1871, on the northern face of the Greater Ararat, where, with Dr. Sievers, we passed the night by the little crater lake Küp-göl, at more than 11,000 feet, and on the 9/21st ascended thence to 14,500 feet. Although snow-water was frozen that morning close to our camp, yet it was not till we had ascended to 14,300 feet that we met with the last dwarfed specimens of *Draba araratica*, Rupr., and *Pedicularis araratica*, Bunge, the latter in flower and ripe fruit. All that applies to the exposed organs of these plants, applies with still greater force to their subterranean life. It is noteworthy that a plant of hardly an inch in height is provided with a fibrous network of perennial roots, extending to more than three to five times that diameter and from ten to fifteen times that circumference. The perennial cushion-like *Alsineæ* and species of *Draba*, for instance, at the highest point of their vertical distribution attain scarcely an inch above the ground, while their main roots reach a length

of ten to twelve inches. At such heights the roots of such plants are remarkably closely tufted. We may mention a similar instance in this aspect of the roots of woody plants in deserts, the Transcaucasian for example, where they attain an extraordinary length. Only in this case the roots run far in the sand apart from each other, no doubt, to seek after the least particle of moisture which the arid soil has to offer. The various species of *Tamarix*, *Haloxylon Ammodendron*, and *Zygophyllum* display this; but the most striking example which I ever saw was that of *Prosopis Stephaniana*, Willd., which, though hardly one foot high, sent out running roots of eight to ten feet in length.

I am now in a position to give all wished-for information regarding any topic of discussion which this paper may give rise to, for the extensive herbarium which I have brought together in the course of twenty-five years, and recently augmented by the collections of the too early deceased Smirnow, are now arranged in the order of Boissier's 'Flora Orientalis,' and the specimens poisoned, so that I have before me all the vouchers for the statements here given. In this communication I include all alpine Phanerogams of the Caucasus, and add the average and extreme altitudes at which hitherto they have been found. Down to 1885 these heights were taken by myself with a barometer of Parrot's construction, with the exception of 1876, when I worked with a large aneroid made by Goldschmitt. These heights were reduced in the topographical department of the General Staff of the Caucasus at Tiflis. The heights measured in 1885 in Daghestan were taken with a Hottinger's aneroid, and computed by Mr. Assafrey, of the Tiflis Physical Observatory. Observations from other sources are appended to mine.

The following works have been laid under contribution:—

LEDEBOUR. 'Flora Rossica;' in which, however, we only find the heights given in round numbers.

C. A. MEYER. 'Verzeichniss der Pflanzen, &c.' St. Petersb., 1831. In this also the values are given in round numbers in hexapods, or toises, =1·95 metr. =6·3976 English feet.

PARROT. 'Reise zum Ararat,' Berlin, 1837; with the heights given in English feet.

BOISSIER. 'Flora Orientalis;' the authority for the systematic order in which our herbarium is arranged, and to which I have appended the heights ascertained by me.

Ruprecht. "Flora Caucasica," in 'Mémoires de l'Académie impériale des Sciences de St. Pétersbourg,' sér. VII., tom. xv. n. 2 (1869).

This exceedingly valuable work offers for my purpose a host of special data, but the renowned author has been almost pedantically fastidious in his mention of altitudes. From a botanical point of view, I confine myself to what has been done by Trautvetter and Boissier. The systematic determination of most species of my collections was effected by Trautvetter, whose account in the 'Acta horti Petropolitani,' i.–x. 1871–1887, may be consulted for details.

Radde. 'Berichte über die biologisch-geographischen Untersuchungen in den Kaukasusländern.' Tiflis, 1866. (Published by the author.)

——. 'Die Chews'uren und ihr Land.' Cassel (Fischer), 1878.

——. 'Reisen an die persisch-russischen Grenze.' Leipzig (Brockhaus), 1886.

——. 'Die Fauna und Flora des südwestlichen Caspi-Gebietes.' Do.

——. 'Aus den daghestanischen Hochalpen.' Gotha (Perthes), 1887.

Before I pass on to the special botanical portion, I must mention where, and when, in the course of my journeys I have explored the high alpine and ice regions.

1864. — I traversed the three main tablelands of Colchis, and then obtained the following heights, which concern the present communication (all altitudes being cited in English feet):—

Dadiasch, snow-line, 9402 ft.; the summit itself, according to Abich, being 9618 ft.

Görgi Pass, 9128 ft., in the stretch from Tomiari to the 9938 ft. high Tschitcharo.

Nöschka Pass, separating the sources of the two Hippos streams.

Naksagar Pass, towards Quirischi, in independent Suania, 8831 ft.

Karet Pass, on the way to the town Adisch in independent Suania, 9696 ft.

Goribolo Peak, 9598 ft.

Mammisson Pass, 9421 ft., according to Ruprecht, 'Flora Caucasica,' n. 444, =9390 ft. and 9253 ft.*

1865.—I travelled in the Achalzi and Imeritia dividing range, then in Abchasia, and by the Nachar Pass to Elbruz. The following are the interesting heights ascertained in this tour:—

Nachar Pass, 9617 ft.

The northern side of Elbruz, Phanerogams occurred higher than 12,000 (determined 12,345 ft.), the highest point reached was 14,295 ft., in the *névé*.

During the journey in 1867 to the sources of the Kura, in the Armenian highlands, and in 1866 to Talysch, the heights which concern us here were not touched. Those also in the journey in 1870 to Talysch and Transcaspia only touched the lower alpine zone in their highest points in Suant-Gäu, 8000 ft.

1871.—This year many heights were ascertained for the first time, and they all refer to the Armenian and Karabagh highlands. Preliminary reports concerning the whole of my Caucasian journeys during the years 1864, 1865, 1867, 1871, 1875–1877, 1879, and 1885 were issued in the corresponding volumes of Petermann's 'Mittheilungen,' and in its Ergänzungsheften, Nos. 36 and 85.

Dibagli. Watershed in Western Karabagh, 9000 ft., eastern foot of Kapudschich 9000 ft., middle of Kapudschich Pass 11,500 ft., height of the peak 12,855 ft.

Kitschil-dagh Pass, 9620 ft.

Pass between the Saganlü and Diktscha-Pelikan ranges, on the south bordering chain of the Gokschai Lake, 10,410 ft.

Alagös, on its south side, the subalpine flora reached 9500 ft.

—— Charagöl, terrace on its south side, 11,500 ft.

——, turf of species of *Carex* at 12,000, and even at 12,300 ft.

——, summit, 13,436 ft.

Aschich-dade, botanical station, 9500 ft.

——, foot of the steep crags, 10,190 ft.

——, northernmost peak, 12,000 ft.

* The reader will find full particulars of the measurements in my work 'Berichte über die biologisch-geographischen Untersuchungen in Kaukasusländern,' p. 147.

Great Ararat, Kupgöl lake, 11,267 ft., according to Parrot 10,933 ft. in English feet.

——, camp on the 8/20 August, 1871, at the northern foot of the great glacier, 11,100 ft. (about 11,000 ft. in the first account).

——, extreme limit of turf plots on its northern side, 12,357 ft.

——, firm basis of the upper edge of the glacier (lower edge of the Calotte), 14,233 ft.

——, camp on 9/21 August, after the descent, 9011 ft.

——, camp 10/22 August, called Estangar, 9853 ft. According to Parrot, the lower edge of the field of *névé* = 11,922 ft.

——, camp, 18th September, 12,426 ft.

——, do, 26th September, 13,122 ft.

——, snow-line twice determined, 13,536 and 13,387 ft.

——, summit 16,916 ft.

Little Ararat, summit 12,840 ft.

Height of pass between the two Ararats, 9156 ft.

1874.—The following heights amongst others to the south of Erzeroum were ascended:—

Palan-töken Pass, the first of that name, 10,155 ft.

——, the second, lying to the west of the former, 9600 ft.

——, summit, according to Strecker 10,485 ft., but the trigonometrical measurements, taken in the course of 1877–79, made it 10,386 ft.

Bingöl-dagh. In Petermann's 'Mittheilungen' for 1877, Heft xi. I gave a special description of this region, with the measurements ascertained to 1874. At present, I confine myself to the figures published by the Topographical department of the Caucasian General Staff. Toprak-Kala, the western peak of Bingöl-dagh, was trigonometrically determined in 1877–79 to be 10,440 ft.; the highest point of Kara-Kala was barometrically reckoned 11,810 ft. by Sauriew; and Demyr-Kala, the easternmost height (which I dealt with in my before-mentioned memoir), was given as 12,087 ft. by Abich, and 12,300 ft. by Tschichatschew. The average altitude of the edge of the crater, where I made my richest botanical harvest, would not be overstated at 10,500 ft.; many species ascend still higher up to 12,000 ft.; Boissier always cites the Bingöl-dagh plants as from 9800 feet only.

1875.—The journeys in this year on the northern side of Alagös, and to other heights in the Armenian highlands, also gave some useful material.

Zchra-Zcharos-mta Pass to the plateau of Achalkalaki, 8807 ft.

Kara-Kaja, also Kara-Kissi, 9351 ft. by triangulation, 9500 ft. by barometer, attaining its highest point in Abul 10,826 ft., and its greatest altitude east of Dali-dagh, Samsar, elevations of from 9000 to upwards of 10,000 ft.

Alagös, northern side, extreme limit of barley culture, 8300 ft.

——, do., botanical station, 10,000 ft.

——, north-west foot of the peak, about 12,000 ft.

1876.—I devoted to travelling through that part of the Great Caucasus which stretches from Kasbek to the Daghestan chain. The following heights are of value for our purpose:—

Archosis-tawi Pass, 10,247 ft.

Anatoris-gele Pass, 10,089 ft.

Azunta Pass, on Tebulos, 12,283 ft.

Tebulos-mta, peak, by triangulation, 14,781 ft.

Kerigo, 11,011 ft.

Camp on Kwawlos-mta, 10,400 ft.

Katschu, peak, 14,027 ft.

Bonos-mta, peak, 13,736 ft.

Kadowanis-mta Pass (Sazchenos-gela), 10,430 ft.

Borbalo, the lesser, 11,552 ft.

Sakoris-tawi Pass, 10,225 ft.

Massara Pass, 10,547 ft., but according to the 5-verst map ct the Imperial Staff 10,129 ft.

1879-80 I spent in Russian Talysch, and travelled through a part of Aderbaidshan and Sawalan. In the outlying chain of the boundary-range of the Talysch mountains the important heights Kusjuroi and Marajurt were discovered to be only 8033 ft. and 8226 ft. I ascended as high as 13,000 ft. on Sawalan, though at the time of the melting of the snow in the beginning of August many species would be obtained at greater heights than I was able to discover them.

1885.—I visited the high alpine districts of Daghestan, from Schah-dagh westwards to Bogos. With reference to the alpine flora, the following discovered heights have value:—

The height of Salawat, above Nucha in the main chain, 11,932 ft., by triangulation, north-westerly.

——, do., south-westerly, below Nucha, 11,932 ft., by triangulation.

Salawat Pass, on the north-west, 10,207 ft.

Tufan-dagh, peak, 13,764 ft., by triangulation.

Pass to the Dolama and Kurwa plateau, 10,640 ft.

Kurwa Pass, summit, 11,247 ft.

Pirli-dagh, camp, 9951 ft.

Schah-dagh, western peak, 13,511 ft., by triangulation.

——, eastern peak, 13,951 ft., by triangulation.

——, do., excursion to, 11,604 ft. last noticed plants; last measurement, 12,136 ft.

Basar-dusy, peak, 14,722 ft., by triangulation.

Schalbus-dagh, peak, 13,679 ft., by triangulation.

——, camp, by the scree on the south side, 10,755 ft.

——, highest camp, 11,280 ft.

Zabachan Pass, 9134 ft.

Iohe Pass near Dulty-dagh, 10,646 ft.

Nussa Pass, 12,185 ft.

Dulty-dagh, northern foot, 9767 ft.

Ketz Pass, watershed between Kara-Koissu and the Awarisch Koissu, 11,503 ft.

Chalata-Kale Pass, towards Kachelien, 9852 ft.

Before passing on, I have the following remarks to make:—

With the exception of the Thalamifloræ, which are enumerated by Ruprecht, the references to altitude in literature are very scanty, so that for the most part I am able only to show the heights which I have myself discovered. The sadly premature death of that celebrated botanist prevented the completion of his classical work. His frequent citations of altitude offer an excellent check for my results, so far as they relate to Daghestan; but it will be seen that in many cases Ruprecht gives a greater maximum altitude for the species concerned than I was able to find, and, on the other hand, I found some at greater heights. Notwithstanding, the difference of heights vary usually only by 200–300 ft. Such differences are easily explained when regard is paid to the position of the place of collection and its exposure, for the species in question.

The general current rule for our region, according to which the snow-line gradually rises in a direction from north-west to

south-east, depending upon the snowfall, holds good also for the vertical distribution of the alpine plants. The more the climate approaches a continental one, so much higher the plants ascend; and the statements of altitudes remind us that many plants which are cited by Boissier from Afghanistan and the north of Persia we find only at considerably greater heights. Those which are isolated are accommodated by the Ararats, Sawalan, and Demawend, and the heights among the Alps of Daghestan range themselves best with those of the Ararats.

Botanical Enumeration.

An asterisk is prefixed to those species which are found at and above 12,000 feet—that is, of the extreme alpine type †.

Thalictrum alpinum, *Linn.* Kasbek, 9200 ft. In the region of alpine meadows. Chanakoi-tau, 8150 ft. (*Owerin*). Found by Ruprecht at Bogos at 9600 ft. (Fl. Cauc. p. 3). The specimens I have before me differ only in degree of development, but in habit are precisely alike.

*Pulsatilla albana, *Stev.*, var. armena, *Rupr.* Bingöl-dagh, 10,000 ft. (*Radde*). Strong seedlings of 16–18 centim. [$6\frac{1}{4}$–$7\frac{1}{2}$ in.] in height, gathered 4/16 August, 1874; the root-leaves are short and weakly developed. Emleki, 10,020 ft. (*Owerin*). According to Ruprecht were gathered by Parrot on Ararat at 10,000–12,000 ft. (Fl. Cauc. p. 3).

Pulsatilla albana, var. flavescens, *Regel.* South side of Schalbus at more than 9000 ft. on 29 June/11 July 1885, also on the ascent to the Iohe Pass at nearly 10,000 ft. on 10/22 July, 1885, gathered by me. The specimens from the former place are distinguishable by their slender and lengthened form of leaf.

Pulsatilla albana, var. violacea, *Rupr.*, Fl. Cauc., was found by him in the Tuschin Alps, and at Bogos up to nearly 10,000 ft. Those specimens of my large set, twelve localities, gathered at 5000–6000 ft., are throughout much more strongly hairy than those growing at its upper limit; it grows upwards from 2500 ft. in the valleys.

We possess the var. andica, *Rupr.*, from the height of 5500–6000 ft. from that author.

† Note.—Approximate equivalents in English linear measure have been added by the Translator to the metric measurements.—Sec. L. S.

ANEMONE NARCISSIFLORA, *Linn.*, var. CHRYSANTHA, *Fisch. & Mey.* Kerigo, at 10,000 ft., 8/20 July, 1876. Elbruz, over 9000 ft., 11/23 August, 1865. Archotis-mta, 10,000 ft., 26 June/10 July, 1876. Azunta, up to 10,000 ft., abundant, 11/23 August, 1876.

In its typical, free-flowering form this species covers most of the lower subalpine meadows about 9000 ft. and descends thence to 4000 ft. That form which is generally recognized by most botanists as only a variety has yellow flowers, is slender in habit, and usually one-flowered. Ruprecht, Fl. Cauc., separated this variety from NARCISSIFLORA, and described it as A. SPECIOSA; he found it in the Chewsur Alps at 10,500 ft.

*RANUNCULUS ARACHNOIDEUS, *C. A. Mey.* This beautiful *Ranunculus* is a true denizen of the high alpine region, and seems to be almost entirely confined to the eastern Caucasus. East of Kasbek, it is very general at heights of 10,000–11,000 ft., as far as Schah-dagh. Ruprecht, Fl. Cauc. p. 17, cites as stations in this district, Dsçhulti-dagh and Artschi-kala, from 11,600–11,850 ft. I have collected this species in the Kurwa Pass at 11,200 ft., the Iohe Pass at 10,600 ft., the Nussa Pass at nearly 12,000, and in the Ketz Pass at 11,400 ft. Up to the present time, only one station in the western Caucasus is known to me, namely on the west side of Elbruz, at 9000 ft. The plant is peculiar in its place of growth; it avoids firm ground, and roots often six to eight inches deep in dry slaty fragments, which have to be removed before the roots can be got at. Both in its form of leaf and spider-web pubescence, the plant is extraordinarily constant from its various places of growth.

RANUNCULUS VILLARSII, *DC.* (syn. *R. oreophilus*, Bieb., *fide* Boissier). This fine species possesses a great range in altitude. The lowest station is about 3000 ft. above sea-level, and the highest fully 10,500 ft. The alpine forms which I gathered came from Borbalo, Kapudschich, and Sawalan, at fully 10,000 ft., and these specimens are only 7–9 centim. [$2\frac{3}{4}$–$3\frac{5}{8}$ in.] high. At lower elevations the plant attains a height of 30–35 centim. [$11\frac{1}{2}$–$13\frac{1}{2}$ in.]. Ruprecht's highest station (Fl. Cauc. p. 18) agrees well enough with those given by me; they are Dindi-dagh, 10,500 ft., and Diklos 10,200 ft.

RANUNCULUS CAUCASICUS, *Bieb.* This species has almost as great a vertical range as the last one, namely from 3600 ft. to

10,600 ft., and even 11,000 ft. The small, extreme alpine specimens have been named by Trautvetter var. ALPICOLA. In my collections they came from Alagös at 11,000 ft. Ruprecht's highest stations are, besides the previously mentioned, Dindidagh, and Komitos-zweri in Tuschetien, at 10,600 ft.

RANUNCULUS MONTANUS, *Willd.*, var. GLABRATA, *Trautv.* My highest specimens were gathered in the Kapudschich Pass (Karabagh) on 15/27 June, 1871, a branching form, and on Sawalan on 20 June/2 July, 1880. In both cases they occurred close to the melting snow at more than 10,500 ft. This species grows a foot high and even more, about the elevation of 5000 ft.

RANUNCULUS ELEGANS, *C. Koch*, = *R. anemonifolius*, DC. My highest grown specimens came from Schah-dagh at about 9500–10,000 ft. In the subalpine zone this species grows slenderly to about eighteen inches high, and is thickly covered with hair.

Of the Papaveraceæ only PAPAVER CAUCASICUM, *Bieb.*, gets into the alpine zone, and that exceptionally. On 12/24 August, 1871, I collected it on my ascent of the Little Ararat, 14 cm. [11½ in.] in height, at an elevation of about something over 10,000 ft. Ruprecht, Fl. Cauc. p. 52, gives this plant from Tufan-dagh at 9500 ft., ascending thither from the sea-level, as occurs in Talysch in the bed of the Leukoranka. I am not able to pass an opinion on Ruprecht's P. OREOPHILUM, but it has also been found in the Mammison Pass at the same elevation.

As regards the alpine species of CORYDALIS (which Ruprecht has generically separated as CAPNITES), C. CONORHIZA, *Ledeb.*, C. OCHROLEUCA, *Rupr.*, and C. PAUCIFLORA, *Steph.*, are most widely distributed. C. CONORHIZA, to which C. MACROSEPALA, *Rupr.*, and C. OCHROLEUCA, *Rupr.*, belong as varieties, is in my herbarium from many localities. It occurs in turfy spots in the subalpine zone throughout the whole of the Caucasian region. We have it also from between 8000–10,000 ft., on Kasbek, Archotis-mta, Diclos, and Borbalo.

At similar altitudes, and up to 11,500 ft., we have C. PAUCIFLORA, *Steph.*, in its variety PARVIFLORA, *Regel*, and C. ALPESTRIS, *C. A. Mey.* Ruprecht's highest station is on Alachun-dagh, in Daghestan, and it there attains its extreme limit. I met with it on Kerigo and Archotis-mta above 10,000 ft. It prefers to grow, like *Ranunculus arachnoideus* and *Pseudovesicaria*, in bare

slaty rubbish, its tuber deep below, and its thin, bright green, delicate stem winding between the fragments of rock in a troublesome fashion, the roots being often a foot in length before reaching the surface.

As regards the species of CARDAMINE, C. IMPATIENS, *Linn.*, C. TENERA, *Gmel.*, and C. ULIGINOSA, *Bieb.*, ascend to a little above 9000 ft., the last reaching nearly to 10,000 ft., following the course of the streams upwards. See Ruprecht, Fl. Cauc. pp. 64, 65.

*ARABIS ALBIDA, *Stev.* This pretty Crucifer inhabits the comprehensive zone between the sea-level and 12,000 ft. It belongs to those plants which, as a rule, prefer localities among the lower elevations, yet passes above the local snow-line, though in such places it rarely flowers. I met with it having ripe pods at 11,200 ft. to 11,400 ft. on the Little Ararat, and followed up its traces almost to the summit. These specimens were uncommonly hairy, as were those also which were gathered at more than 11,000 ft., and on Alagös, and were 9–10 cm. [$3\frac{1}{2}$–4 in.] in height. Our herbarium possesses specimens from Kapudschich at 12,000 ft., collected by Mr. Owerin; as this prematurely deceased topographer was extraordinarily accurate in his altitudes, I have no doubt of the correctness of his communication. The said examples are very dwarf, the leaves, which are very pubescent, are in a compressed rosette, close to the root; one only bears three ripe pods (August), the other had not reached the flowering stage.

ERYSIMUM GELIDUM, *Bunge*, I obtained at quite 10,000 ft., both on Alagös and from Bingöl-dagh. Ruprecht cites it from the Tschingel, in Turkey, at 10,600 ft.

*SISYMBRIUM HUETII, *Trautv.*,=*Arabis Huetii*, Boiss.,=*Arabidopsis pinnatifida*, var. *caucasica*, Rupr. The extreme altitude given by Ruprecht, Fl. Cauc. p. 87, is 11,500 ft. I found it almost at the top of Azunta, 12,000 ft.; on the Archotis-mta at 10,200 ft. It descended thence as low as 7500 ft., and grew chiefly on wet masses of slate scree, and at the elevation of nearly 9000 ft. it still attained a height of a foot. I also got it in the Armenian highlands, on Alagös, at 10,200 ft.

ANCHONIUM ELYCHRYSIFOLIUM, *Boiss.* I gathered this, one of the most stately of Crucifers, in a fruiting stage, on Bingöl-

dagh, on 4/16 August, 1874: it was 16–20 cm. [6¼–8 in.] high. Boiss. Fl. Orient. i. 240, cites it from a similar altitude.

*Pseudovesicaria digitata, *C. A. Mey.* Another of the extreme alpine forms, which penetrates to the extreme highest points, where the snow melts. Ruprecht, Fl. Cauc. p. 97, says:—"In monte Djultidagh ad moles glaciales alt. 1690 hex. 20 Jul. fruct. et flor. pallide roseo-lilacinis; ibidem alt. 1840 hex. [11,700 ft.] specimen pollicare albiflorum legi . . ." I obtained this species from the Kurwa Pass at 11,200 ft., on 26 June/8 July, 1885, flowering freely, and with only the first rudiments of fruits; the tiny plants were from 5 to 10 cm. [2–4 in.] high: from the southern declivity of Kwawlos-mta, 10/22 July, 1876, in fruit 12–17 cm. [5–6¾ in.] high, with a simple root of the same length, whose tender lateral branches clung to the sharp fragments of slate. From Kerigo, 11,000 ft., 8/20 July, 1876, 5–10 cm. [2–4 in.] high, only in flower. Also received from Ruprecht, from Bogos, Tindal, Djulti-dagh, 14,000 ft., 19/31 July, 1860, in ripe fruit: from the upper regions of Tusch, 4/16 August, 1861, 7 cm. [2¾ in.] high, in flower and fruit. Bayern collected it at Bogos in 1860 and Azuntabl.

Alyssum alpestre, *Linn.* var. typ. *Trautv.*, I gathered at Schah-dagh on 27 June/9 July, 1885, above 11,000 ft.

Of the genus Draba, which is comparatively well represented, the undermentioned species are alpine.

*Draba bruniæfolia, *Stev.* I have records of eighteen stations for this little plant in the Caucasus. The specimens in question show, besides their individual variation, the height at which they were gathered in a sufficient degree. My specimens from the highest station were from Sawalan at 12,300 ft., are about 2 cm. [1 in.] high, and in full flower, on the 20 June/2 July, 1871; and the same holds good with those from Bingöl-dagh at 11,000 ft., on 4/16 August, 1874. At 7000–9000 ft. the plant is 7–9 cm. [2¾–3⅝ in.], with leaves three or four times longer, and almost entirely glabrous. Ruprecht gives the maximum height at 11,500 ft.

Draba scabra, *C. A. Mey.* Ascends on the northern side of Elbruz to about 11,000 ft.; 10/22 August, 1865. Ruprecht, Fl. Cauc. p. 107, gives its highest elevation at 10,600 ft.

DRABA RIGIDA, *Willd.* This species grows as low as 3500 ft. above sea-level, but here it takes on a special facies, due to its abundant leaf-development; it is then the variety TOURNEFORTIANA, *Rupr.* Fl. Cauc. p. 109: I have it from the defile of Blo, end of June, 1876. It also occurs in very shady places on the rocks in the defile of Darial, and the alpine form, called BRYOIDES, *DC.*, is found at lower heights, as certified by the specimens which Ruprecht collected on 14/26 May, 1860, at 4200 ft. The highest stations discovered by me are Kerigo, Kwawlas-mta, and Borbalo, situated above 10,000 ft. In the supplemental volume to his 'Flora Orientalis,' Boissier has followed the example of Ruprecht in treating as a variety of *D. rigida* the formerly specifically distinguished *D. imbricata*, C. A. Mey. This species or variety, as variously considered, ascends to its maximum at Anschabala, as given by Ruprecht, Fl. Cauc. p. 112, as 1880 hexp.=12,013 ft. Even at 11,000 ft., on Borbalo, the little plants had assumed the dwarf form, flowers and pods were almost sessile, with a stem of 3–4 mm. [$\frac{1}{8}$-$\frac{1}{6}$ in.], and cushions of radical leaves.

DRABA MOLLISSIMA, *Stev.* I brought this with me from Schah-dagh, 27 June/9 July, 1885.

DRABA INCOMPTA, *Stev.* Collected by Bayern at Bogos, and stated by Ruprecht, Fl. Cauc. p. 113, to reach its maximum altitude on Schah-dagh at 9300 ft.

DRABA SUPRANIVALIS, *Rupr.* For this I have to thank the kindness of the author of the species, who states (Fl. Cauc. p. 116) it attains its maximum at 1750 hexap.=11,182 ft., and writes:—" . . . inter mt. Sadischi et Pizarro in rupibus fere perpendicularibus pariter *super regionem nivalem.*"

*DRABA ARARATICA, *Rupr.*,=*D. incompta*, Ledeb. non Stev., cf. Fl. Cauc. p. 114. Ascends the highest of all species of *Draba*, and in company with *Pedicularis araratica*, Bunge. Ruprecht assigns to Parrot's Ararat specimens the altitude of 2166 hexap. =13,840 ft. as their maximum; they were collected 29 September, 1829. On 9/21 August, 1871, I found this species at the height of 14,000 ft., not far from the solid edge of the glacier, in single, very reduced dwarf patches, of which very few in that year reached the flowering state. Flower and fruit stems attained hardly 10–12 cm. [4–5 in.] high, with slight hairiness, the tufts were scarcely 2 cm. [1 in.] high, while single roots were 15–20

cm. [6–8 in.] in length. The same species I brought with me from Alagös from fully 11,000 ft. Finally I discovered it in August 1875 in comparatively low quarters, in the Zchra-Zcharo Pass, on the mountain edge, at 8800 ft.

Draba hispida, *Willd.*, was known to Ruprecht as occurring at 10,479 ft. in the Tuschin Alps. Boissier and Trautvetter unite it with *D. tridentata*, DC., which I have gathered on Archotis-mta, at 10,200 ft., but it grows much lower down, for instance it thrives at 4500 ft. in Abastuman.

Draba repens, *Bieb.* According to Ruprecht, this species inhabits both the Gürtels from 2900 ft. to 9600 ft., but it does not descend below the high grassy plots, as shown by my specimens, from the foot of the Kwawlos-mta, at nearly 10,000 ft.

*Draba siliquosa, *Bieb.* Ruprecht, Fl. Cauc. p. 119, gives the maximum altitude at 1940 hexp. = 12,396 ft.; my highest stations were on Sawalan, at close upon 12,000 ft., on 20 June/2 July, 1880; on Archotis-mta at 10,200 ft.; and on Borbalo at about 11,000 ft. In the subalpine zone this plant reaches the height of 15–20 cm. [6–8 in.].

Draba nemorosa, *Linn.*, takes in the wide zone of 1000 ft. to 11,000 ft., but is rare in those districts which lie above the subalpine zone. I collected specimens nine inches to a foot high at Tiflis, at 9000 ft. My highest stations were on Sawalan between 10,000–11,000 ft., on 20 June/2 July, 1880. Ruprecht, Fl. Cauc. p. 127, says that its maximum elevation is 9600 ft.

Didymophysa Aucheri, *Boiss.* I met with this on both the Great and Little Ararat on 9/21–12/24 August, 1871, but not on Russian territory: it was gathered at fully 11,000 ft.

Heldreichia rotundifolia, *Boiss.*, I brought with me from the same locality as that mentioned by Boissier, Fl. Orient. i. 320, from a height of over 10,500 ft., and very close upon 11,000 ft.; here the species was in the closest proximity to the perpetual snow which covers the inner edge of the crater; it reached the height of a foot at the time of flowering, on 4/16 August, 1874.

Capsella Bursa-Pastoris, *Moench*, in many localities ascends far above the subalpine zone, and I gathered it in a dwarf form, hardly 2–4 cm. [1–1$\frac{5}{8}$ in.] in height, both on Alagös and on Sawalan.

[THLASPI PUMILUM, *Ledeb.* This I do not possess. Ruprecht, Fl. Cauc. p. 127, cites it both from Schah-dagh and Elbruz, and unites it with *Æthionema rubescens*, Boiss., which is found in the Cilician Taurus up to 12,780 ft.]

*EUNOMIA ROTUNDIFOLIA, *C. A. Mey.* This pretty *Æthionema*-like Crucifer also attains the region where the snow melts last, and its stunted, highest individuals are found on the north side of Elbruz at fully 12,000 ft. above the sea. I gathered it there at 11,000 ft. in flower, 10/22 August, 1865; and brought strong clumps of it from Abulstock to the south of the Tabizkur lake at 9000 ft. and more. Ruprecht's view, Fl. Cauc. p. 128, that the species belongs only to the Great Caucasus, therefore requires correction.

Four species of Violet ascend to the snow-line in the Caucasus, and one of them beyond it; the last is

*VIOLA MINUTA, *Bieb.* I have this species from the high Alps of the Great Caucasus. A little below the Azunta Pass, at 12,000 ft., it was in flower on 5/17 July, 1876, and these specimens were thoroughly robust. Ruprecht, Fl. Cauc. p. 158, cites Alagh-dagh, at 11,880 ft., as a station.

VIOLA PURPUREA, *Stev.*, is mentioned by that botanist as flowering in the snow on 9/21 June, 1810, which height is underestimated by Ruprecht, Fl. Cauc. p. 146, at 8300 ft.; in ordinary seasons, at least, it grows at the same heights as the most luxuriant of the subalpine flora. According to my experience the elevation must be considered as upwards of 10,000 ft. Owerin reports this at 9000 ft. from Chanakoi-tau. The lowest station may be reckoned at 2500 ft.

VIOLA ARENARIA, *DC.*,=*V. rupestris*, Schmidt (Boiss. Fl. Orient. i. 72), is reported by Ruprecht, Fl. Cauc. 154, from the Great Ararat at 10,800 ft. *Viola biflora*, according to the same author, reaches a maximum altitude of 10,200 ft.

VIOLA ALTAICA, *Pall.*,=*V. oreades*, Bieb. My highest station for this charming species lies on the north side of the Nussa Pass at 10,500 ft.; Ruprecht, Fl. Cauc. p. 159, cites it from the source of the Malka, on Elbruz, as being 10,645 ft.

VIOLA DICHROA, *Boiss. & Huet*, I brought from the Bingöl-dagh, from upwards of 10,500 ft.

Of the numerous species of Pink which grow in the Caucasus I have only one to name as attaining the highest alpine zone. This is

*DIANTHUS PETRÆUS, *Bieb.*, var. MULTICAULIS, *Boiss.* According to Parrot (Ruprecht, Fl. Cauc. p. 170), this species is met with on Ararat at as high as 12,700 ft. I gathered it on Bingöl-dagh at more than 10,500 ft., the specimens were 10–11 cm. [4–4$\frac{1}{2}$ in.] in height, in full flower, 4/16 August, 1874. This *Dianthus* embraces the wide zone of 0–12,700 ft., as I found it on rocks near Lenkoran in the low country.

Of the large series of the genus *Silene*, there are only two which are truly alpine, one of which has a very restricted vertical range: that is, the tiny

SILENE HUMILIS, *C. A. Mey.*, which species inhabits the high Alps of Daghestan, from Tufan-dagh to Bogos. I found it at 10,400 ft. in the Iohe Pass. Ruprecht noted there its maximum altitude as 1750 hexp.=11,180 ft.

SILENE SAXATILIS, *Bieb.*, was collected by the latter author, at the Dschulti springs (Artschi-kala) at 11,629 ft., flowering when 7 inches high, on 19 July.

ALSINE PINIFOLIA, *Fenzl*, var. ROBUSTA, and var. PUMILA, *Fenzl*,=*A. caucasica*, Rupr. (Boiss. Fl. Orient. supp. p. 111). My highest station for the former lies on Archotis-mta at 10,200 ft.; the latter variety at the foot of the Lazal. Ruprecht, Fl. Cauc. p. 204, reports the plant from Azunda at 11,370 ft.

ALSINE AIZOIDES, *Boiss.* Collected in the neighbourhood of the melting snow, on Salawan at 11,000 ft., 20 June/2 July. Found also by Küp-göl at 11,400 ft. on 9/21 August, 1871. Djulti at 11,400 ft. by Ruprecht.

ALSINE IMBRICATA, *Bieb.*, dwells throughout the broad zone between 3500 ft. to nearly 12,000 ft. In the upper regions, the variety VESTITA, *Fenzl*, occurs, making strong roots and stolons, ten or twelve times the length of the above-ground portions. My extreme station is Azunta, at 12,000 ft. Ruprecht, Fl. Cauc. p. 209, records the plant from the summit of Artscha-kala, 11,500 ft. Specimens are in the herbarium from all the high passes of the Great Caucasus.

*ALSINE RECURVA, *All.* This, again, is a species which oversteps the snow-line in favourable localities. I gathered it on the summit of the Little Ararat thus at the height of 12,850 ft. Parrot, 'Reise zum Ararat,' p. 213, was aware of its lofty station; his statement of 2000–2166 hexp.=12,780–13,840 ft., refers to the Great Ararat. This high alpine form belongs to the variety HIRSUTA, *Fenzl.* I met with this species on almost every high alpine locality. Ruprecht, Fl. Cauc. 212, gives its lowest occurrence at Sülak at 300 hexp.=1917 ft.

ALSINE JUNIPERINA, *Fenzl*, var. VILLOSULA, *C. Koch.* I follow the example of my esteemed friend Von Trautvetter in uniting with this *A. Villarsii*, Fenzl, and *A. Biebersteinii*, Rupr. This species begins at 3000 ft. above the sea, and my highest point up to the present, is from the Küp-göl, at 11,300 ft.

ALSINE VERNA, *Linn.*, var. RUBELLA, *Wahlenb.* (Boiss. Fl. Orient. supp. 113), is known from 10,700 ft. on the Tufan-dagh. Ruprecht, Fl. Cauc. p. 214.

ARENARIA (§ EREMOGONE) LYCHNIDEA, *Bieb.* Its highest elevation is given by Ruprecht, Fl. Cauc. p. 219, from Azunta, at 11,200 ft. I have often found it in high alpine spots in the Great Caucasus, at 9000–10,000 ft.

CERASTIUM TRIGYNUM, *Vill.* My highest station is at Küp-göl at 11,200 ft. Ruprecht records its maximum altitude at 11,600 ft. for the Great Caucasus, and its minimum as 5000 ft. On Sawalan it ascends as high as 11,000 ft.

*CERASTIUM KASBEK, *Parrot*, was collected by the first climber of Ararat, Parrot, on 29 September, 1829, at 2106 hexp.=13,800 ft. I gathered this species in many of the high passes in Daghestan, thus from Nussa at 12,100 ft., and Ketz 11,400 ft. My lowest stations were on Kerigo and Kwawlos-mta, at more than 10,000 ft. The rare *Parnassius Nordmanni* was resting on this plant in the Ketz Pass on 6/18 August, 1885. General Chodzko brought it from the Alachan-dagh at 1979 hexp.=12,645 ft. (Ruprecht, Fl. Cauc. p. 226), and the same author gives its minimum point on Bogos at 1235 hexp.=7900 ft., though at this level it is rare (*l. c.* p. 225).

CERASTIUM MULTIFLORUM, *C. A. Mey.* A common alpine plant, which descends thence to 5000 ft. Ruprecht's statement accords well with my highest station on Borbalo at 10,000 ft.

*CERASTIUM PURPURASCENS, *Adams*, var. TENUICAULIS, *Trautv.* This I collected on the north side of the Great Aarat, at upwards of 12,000 ft.; I brought the same plant from Murat-tapa at 10,400 ft., and met with the typical form flowering on Elbruz at 11,300 ft.; I also observed it in a flowerless dwarf condition on the north side of Elbruz above 12,000 ft. This free-blooming species of *Cerastium* is a delicate ornament of many localities in the Caucasus; it is the prevailing species in many places, which it decks with an almost complete white covering in its time of flowering. Ruprecht, Fl. Cauc. 235, gives its minimum elevation at 5700 ft.; but I have collected the var. MICROSPERMA on Schambobell at 5000 ft.

*CERASTIUM LATIFOLIUM, *Linn.*, = *C. polymorphum*, Ruprecht, Fl. Cauc. 237, is cited by that author from Azunta at 11,500 ft., and is reported from many heights in the Great Caucasus of 9500–10,000 ft.; he also (*l. c.* p. 239) cites my station for *C. purpurascens*, from Elbruz, as also applying to this species.

*CERASTIUM ARARATICUM, *Rupr.* Information concerning the allied species is supplied by Ruprecht, Fl. Cauc. 234, and Boissier, Fl. Orient. supp. 120. Von Trautvetter determined my series, which came from Küp-göl at more than 11,300 ft., from the Little Ararat close to the summit 12,800 ft., from Kapudschich 11,000 ft. (large flowering form), from Bingöl-dagh above 10,000 ft., and from Aschich-dagh, 9500 ft.

HERNIARIA CAUCASICA, *Rupr.* Hitherto only known from the eastern regions of the Great Caucasus, and there at the heights of 9500–11,500 ft.; see Ruprecht, Fl. Cauc. p. 241.

SCLERANTHUS ANNUUS, *Linn.*, β. UNCINATUS, *Rupr.* Fl. Cauc. 242. Recorded up to 10,350 ft.

HYPERICUM REPENS, *Linn.*, = *H. polygonifolium*, Rupr. Fl. Cauc. 247, has been found in Daghestan as high as 10,200 ft.

Of the numerous species of *Astragalus* in the Caucasian herbarium, the following are noted from the alpine districts:—

ASTRAGALUS DECLINATUS, *Willd.* This species ascends to 11,400 ft. on Schah-dagh, and I have also gathered it on Dulty-dagh, on Lazal, and other high alpine parts of Daghestan.

ASTRAGALUS SANGUINOLENTUS, *Bieb.* On Schah-dagh, almost as high as the preceding species.

Astragalus xerophilus, *Ledeb.* I brought this from the Great and Little Ararat; those specimens gathered at Küp-göl at 11,200 ft. are very robust.

Astragalus incertus, *Ledeb.*, and A. coarctatus, *Trautv.* From the same stations as the foregoing, at fully 11,000 ft.

Oxytropis albana, *Stev.*, var. albiflora, *Trautv.*, I brought from Küp-göl, the Little Ararat, Kapudschich, and the Iohe Pass at heights of 10,400–11,500 ft.

Oxytropis cyanea, *Bieb.* On Schah-dagh above 11,000 ft.

Hedysarum obscurum, *Linn.* On the margin of the crater of Bingöl-dagh at quite 10,500 ft.

Onobrychis cornuta, *Linn.* The thorny cushions were very luxuriant at fully 10,000 ft. on the Schah-dagh.

Rubus saxatilis, *Linn.*, and Dryas octopetala, *Linn.*, have hitherto not been found above 9000 ft. in the Caucasus. The former grows in the birch thickets in the pass between the two Ararats; the latter was gathered by Owerin on the Lesser Chanakoi-tau at 8450 ft., and I found it in August 1875 on Kasbek at 9000 ft.

Potentilla sericea, *Linn.*, var. dasyphylla, *Trautv.*, and var. subpalmata, *Ledeb.*, collected on the Great Ararat at over 11,000 ft. on 9/11 August.

Potentilla argæa, *Boiss. & Bal.* I have this before me, gathered on Alagös in 1871 and 1875; also from Kapudschich from the altitudes of 9000 ft. to over 11,000 ft.: the specimens growing at the lower level attained a length of flower-stem of more than eight inches. I have, besides, strong specimens of dwarf type from Bingöl-dagh and Sawalan from upwards of 10,000–11,000 ft.

Potentilla multifida, *Linn.* Those specimens which were gathered at Schah-dagh at over 11,000 ft., 27 June/9 July, 1885, were in a scanty state of flowering; but those from Sawalan, at close upon 12,000 ft., complete the set.

Potentilla verna, *Linn.* Specimens from Kerigo and Borbalo gathered 8/20–15/27 July, 1876, were of the alpine character, at over 10,000 ft. In the subalpine zone and lower down, to 5000 ft., it becomes very robust and nearly a foot high.

Potentilla alpestris, *Hall.* I quote from Ruprecht in Boissier, Fl. Orient. ii. 720, from Daghestan at 11,000 ft.

Potentilla gelida, *C. A. Mey.* Dwarf specimens grew on Sawalan at 9500 ft., on 14/26 June, 1885. Strong plants were gathered on Schalbus, 29 June/11 July, as much as 12 cm. high; others came from Elbruz, Kasbek, and Kerigo, at similar altitudes. Ruprecht, Fl. Cauc. 724, gives the greatest height in Daghestan as 11,600 ft.

Potentilla nivea, *Linn.*, is cited by Steven, C. A. Meyer, and Ruprecht from Daghestan at up to 10,000 ft.

Sibbaldia procumbens, *Linn.* (= *Potentilla Sibbaldi*, Hall. f.) Very common at elevations of 8000–10,000 ft., those which were gathered at Küp-göl at above 11,000 ft. were strong specimens, 10 cm. [4 in.] high, full of flower and forming patches; by 9/21 August past flowering.

Alchemilla vulgaris, *Linn.*, and A. sericea, *Willd.* I have both of these from Küp-göl at more than 11,000 ft., the former was 15 cm. [6 in.] high, and very hairy. Ruprecht gives the maximum for both as 9600 ft. in the Caucasus. The former descends to 2000 ft.

*Sedum tenellum, *Bieb.* I have this from all the high alpine localities which I have visited in the Caucasus—from Alagös, both the Ararats, Kapudschich, Borbalo, Elbruz, Kasbek, &c., ranging from 9000–12,000 ft. At more than 10,000 ft. I found the little plants 9–10 cm. [3½–4 in.] in height; also at Küp-göl it was just as strong. The highest station was on the Great Ararat at 13,500 ft.; those there gathered are almost destitute of stem, with solitary flowers on stalks 15 mm. [¾ in.] high, the leaves almost imbricate and a little broader than is usual with plants which grow at lower elevations. Ruprecht, Fl. Cauc. p. 782, gives the maximum height for the eastern Caucasus at 10,500 ft., and the minimum at 6000 ft.

Sedum nanum, *Boiss.* From Bingöl-dagh at 9000–10,000 ft.; the tiniest of all the species, covering the dried up snow-water pools in the crater of the extinct volcano; it was gathered by Haussknecht at 12,000 ft. in Persia.

Sedum globiferum, *Linn.* On Bingöl-dagh at 10,000 ft.

SAXIFRAGA LÆVIS, *Bieb.* I gathered specimens 5 cm. [2½ in.] high on Schah-dagh, 27 June/9 July, 1885.

SAXIFRAGA JUNIPERINA, *Adam.* My highest station was on the Kapudschich at nearly 12,000 ft.; flowering specimens hardly 2 cm. [1 in.] high, 15/27 June, 1871.

SAXIFRAGA EXARATA, *Vill.* I have this species from all the heights of Caucasia. The greatest elevation is Kapudschich at almost 12,000 ft., and at the same level on the Great Ararat; at 6000 ft. it produces a radical-leaved form, with flowering-stems of 12 cm. [5 in.] in height, as, for instance, in the Upper Kura, in a northern aspect.

*SAXIFRAGA MUSCOIDES, *Wulf.* From all the high alpine quarters. My highest station is from the summit of the Little Ararat, at 12,800 ft.; these specimens bear a single flower on a stalk of only 15 mm. [¾ in.] high. Ruprecht cites 11,500 ft. as the maximum altitude for Daghestan.

*SAXIFRAGA SIBIRICA, *Linn.* At heights of more than 11,000 ft. on Kapudschich, and the Great Ararat at nearly 12,000 ft., where it was still only 5–7 cm. [2–2¾ in.] high and single-flowered; it descends as low as 7000 ft. in the subalpine meadows, and then reaches a height of 18 cm. [7 in.] with many flowers. I have the plant before me from all the high stations which I have noticed, twenty-two in number. Ruprecht, Fl. Cauc. ii. 807, gives the maximum height for Daghestan at 11,800 ft.

SAXIFRAGA HIRCULUS, *Linn.* Specimens brought from the Great Ararat at over 11,000 ft., 10 cm. [4 in.] high, on 9/21 August, 1871; for the most part still in flower.

SAXIFRAGA FLAGELLARIS, *Willd.* I brought this from Elbruz at 9000 ft., Kasbek from over 10,000 ft., from Borbalo, Kerigo, Tschauchi, and Nussa from heights of 10,000 to fully 11,000 ft. Ruprecht, Fl. Cauc. 809, cites the zone of its occurrence in Daghestan as from 7600 ft. to 11,000 ft.

SAXIFRAGA CYMBALARIA, *Linn.* On Sawalan up to 10,000 ft.

*CHAMÆSCIADIUM FLAVESCENS, *C. A. Mey.*, *C. acaule*, Bieb., was collected at heights of from 7000 ft. to 12,000 ft. The specimens from the greatest altitude came from the Great Ararat at the last-named elevation, where, from the strong roots,

inflorescences of 2 cm. [1 in.] high were thrown up. At Küp-göl it was as much as 10 cm. [4 in.] high; and from elevations of 7000–8000 ft. I possess specimens of 20 to 25 cm. [8–10 in.] in height. Ruprecht gives the maximum altitude for Daghestan as 9600 ft.

Chærophyllum humile, *Stev.* From Borbalo and Schalbus at over 10,000 ft. Ruprecht, Fl. Cauc. 908, states 9600 ft. to be the maximum for Daghestan.

Anthriscus nemorosa, *Bieb.*, var. glabra, *Boiss.*, Fl. Orient. ii. p. 911. In hollows between rocks in the crater margin on Bingöl-dagh at 10,500 ft., 4/16 August, 1874; the specimens were three to five feet high.

Heracleum incanum, *Boiss. & Huet.* In the same localities as the *Anthriscus.*

Symphyoloma graveolens, *C. A. Mey.* From the Great Caucasus, especially the Daghestan Alps, reaching as high as 10,500 ft. in the Iohe Pass. Ruprecht, Fl. Cauc. 1063, gives its occurrence in the same regions at 9000–10,000 ft.

Asperula aspera, *Bieb.*, var. brachystegia, *Boiss.* On Bingöl-dagh at 10,000 ft.

Valeriana daghestanica, *Rupr.*; see Boiss. Fl. Orient. iii. p. 87. Discovered by Ruprecht on Djulti-dagh at 10,500 ft.

Valeriana sisymbriifolia, *Desf.* Occurs on Bingöl-dagh at 9000 ft., and was found by Haussknecht in the Alps of South-west Persia at 13,000 ft.

Valeriana leucophæa, *DC.* On Bingöl-dagh at 10,500 ft.; on Sawalan at nearly 11,000 ft., noted by myself.

Betckea caucasica, *Boiss.* Ascending the Iohe Pass to 10,400 ft.; recorded by Ruprecht at 9000–9600 ft. in Daghestan; see Boiss. Fl. Orient. iii. 94.

Aster alpinus, *Linn.* Reaches nearly to 10,000 ft.

Erigeron pulchellum, *Willd.* Was collected on Bingöl-dagh at fully 10,000 ft., on 4/16 August, 1874; and I found it at Küp-göl a foot high at more than 11,000 ft. on 8/20 August, 1871. Ruprecht gives the elevation in the Caucasus at 9600 ft.

ERIGERON ALPINUM, *Linn.*, var. ERIOCALYX, *Ledeb.* Grows on Kwawlos-mta at 10,000 ft. as a solitary-flowered little plant, of 8–12 cm. [$3\frac{1}{8}$–5 in.] high, but in the subalpine zone is as much as 30 cm. in height.

ANTENNARIA DIOICA, *Linn.* Ascends on Archotis-dagh and Kasbek to close upon 10,000 ft.

GNAPHALIUM SUPINUM, *Linn.*, var. SUBACAULE, *Wahlenb.* In its dwarf form ascends to a great altitude, and is reported by Ruprecht, Fl. Cauc. iii. 227, from Daghestan up to 11,000 ft. My stations are Kwawlos-mta and Borbalo.

HELICHRYSUM AURANTIACUM, *Boiss. & Huet,*=*H. lavandulæfolium*, Willd. On Bingöl-dagh at quite 10,500 ft., on the Great Ararat, found near Küp-göl above 11,000 ft., and there in strong, well-flowering specimens, 10–13 cm. [4–$5\frac{1}{4}$ in.] high.

ANTHEMIS BIEBERSTEINIANA, *Adam*, = *A. Marschalliana*, Willd., var. *β. Rudolphiana*, C. A. Mey. Gathered on the south side of Schalbus, at 10,700 ft., 5–7 cm. [2–$2\frac{3}{4}$ in.] in height, though only single-flowered, on 29 June/10 July, 1885.

ANTHEMIS IBERICA, *Bieb.*, var. BUNGEANA, *Trautv.* Specimens with very matted tomentum, 10–12 cm. [4–$4\frac{3}{4}$ in.] high, were collected on the 9/21 August, 1871, at Küp-göl at 11,000 ft.; the typical form is also before me from Borbalo at 10,000 ft., and Kasbek. Ruprecht, Fl. Cauc. 289, gives the maximum for Daghestan at 10,500 ft.

CHAMÆMELUM CAUCASICUM, *Willd.* At its maximum height at Küp-göl, 11,000 ft., in flower 9/21 August, 1871, and in the subalpine zone it was as much as 30 cm. [$11\frac{5}{8}$ in.] high. Reported by Ruprecht, Fl. Cauc. 331, as attaining 10,000 ft.

ARTEMISIA SPLENDENS, *Willd.* Dwarf specimens at its greatest altitude at Küp-göl at 11,000 ft., and on Bingöl-dagh at 10,000 ft., 20 cm. [8 in.] in height.

SENECIO VERNALIS, *Waldst. & Kit.* Ascends through all the zones from the level of the sea, where it is three feet high, up the courses of the streams, to more than 10,000 ft., at last hardly 4–5 cm. [$1\frac{5}{8}$–2 in.] in height, and then growing in tufted communities, amongst damp, slaty rubbish. Cited by Ruprecht as reaching to 10,500 ft. in Daghestan, Fl. Cauc. 389.

SENECIO CAUCASICUS, *Bieb.*, and S. RENIFOLIUS, *C. A. Mey.*, were found by Ruprecht at 9800 ft. and 9600 ft.

SENECIO TAXIFOLIUS, *Bieb.* In both the Great and Little Caucasus; it attains the elevation of 10,500 ft., and on Sawalan ascends still higher, see Boiss. Fl. Orient. iii. 414.

JURINEA DEPRESSA, *C. A. Mey.* From Alagös, on its northern side, at more than 10,000 ft.; and found by Ruprecht in Daghestan at 10,500 ft., see Boiss. Fl. Orient. iii. 583.

ÆTHEOPAPPUS PULCHERRIMA, *Willd.*, β. CONCINNUS. Specimens almost devoid of stem were gathered on Aschich-dade at nearly 10,000 ft., and specimens got from close to the edge of the crater of Bingöl-dagh are as much as 25 cm. [10 in.] high.

CENTAUREA AXILLARIS, *Willd.*, δ. CANA, *Boiss.* On Bingöl-dagh at fully 10,000 ft., and 12–14 cm. [5–6$\frac{5}{8}$ in.] high, 4/16 August, 1874. The plant named by Trautvetter *C. montana*, Linn., var. *albida*, DC., belongs to this; it was collected by me at Küp-göl on 9/21 August, 1871, 15 cm. [6 in.] in height.

TARAXACUM CREPIDIFORME, *DC.*, var. BREVIINVOLUCRATA, *Trautv.* Specimens are before me from all the highest points of the entire district travelled over. The maximum height for the species is on Great Ararat and Schah-dagh at more than 11,000 ft.

TARAXACUM OFFICINALE, *Weber*, var. STEVENI, *Boiss.*,=*T. Steveni*, DC. A single dwarf specimen lies before me, 8 cm. [3$\frac{1}{8}$ in.] high, gathered at 10,000 ft. on Elbruz, 10/22 August, 1865.

CAMPANULA COLLINA, *Bieb.* Known to Ruprecht as a dwarf plant from Daghestan, where it is solitary-flowered at 10,000 ft.

CAMPANULA CILIATA, *Stev.* On Schah-dagh at above 10,000 ft., flowering when 8 cm. [3$\frac{1}{8}$ in.] high, 27 June/9 July, 1885.

CAMPANULA TRIDENTATA, *Linn.*, var. RUPESTRIS, *Trautv.* I have gathered this from thirty localities in the upper alpine zone, throughout the whole region; its greatest altitude is close upon 10,000 ft.; the closely allied species C. SAXIFRAGA, *Bieb.*, I possess only from lower elevations, 4500–9000 ft.

CAMPANULA LEDEBOURII, *Trautv.* Discovered by me on Küp-göl at more than 11,000 ft., and also on Great Ararat 8/21 August, 1871.

Campanula Aucheri, *DC.* Gathered in as many and similar localities as *C. tridentata.* Maximum elevation above 11,000 ft. The plants collected on 8/20–9/21 August, 1871, formed good sized cushions with a flowering-stem of 12–15 cm. [5-6 in.]. Ruprecht and C. A. Meyer knew of it from the Great Caucasus at 10,000 ft.

Campanula petrophila, *Rupr.* This species also attains the elevation of 10,000 ft. from 5000 ft. upwards. See Boissier, Fl. Orient. iii. 903–907.

Campanula Steveni, *Bieb.* Fully to 10,000 ft.; those specimens gathered on the edge of the crater of Bingöl-dagh still partially in flower, 4/16 August, 1874, had leaf-stalks of not less than 20 cm. [8 in.].

Androsace villosa, *Linn.* Maximum altitude on Sawalan upwards of 11,000 ft., in the Afghan Alps 15,000 ft., according to Boissier, Fl. Orient. iv. 14. In the Great Caucasus 10,000 ft.

Androsace albana, *Stev.* On Kerigo almost up to 10,000 ft.

Primula amœna, *Bieb.* Embraces the whole zone between 4500 ft. to upwards of 10,000 ft. The maximum elevations are at the foot of Azunta and the sources of the Ingur, in which case it is the variety Meyeri, Rupr.

Primula nivalis, *Pall.*, was collected in strong examples with flowering-stems of 15–17 cm. [6–7 in.] on the Archotis-tawi Pass, at 10,200 ft., 28 June/10 July, 1876.

Primula auriculata, *Lam.* The copious series collected on Sawalan on 20 June/2 July, 1880, come from nearly 10,000 ft. In the western portion of the Great Caucasus I found this species at 8000 ft., variety glacialis, *Adam.* In the country of the Chewsurs it ascends considerably higher, and the same in Daghestan; and it is known at 11,000 ft. from the Afghan Alps; see Boiss. Fl. Orient. iv. 28.

*Primula algida, *Adam.* Specimens from Alagös attain a height of 2–5 cm. at 12,000 ft., to which it ascends from 5000 ft.: this species is very widely distributed; I have it from all alpine localities of 10,000 ft. which I have visited; it is reported by Meyer, Ruprecht, and Rehmann from the Great Caucasus.

GENTIANA CAUCASICA, *Bieb.* My highest stations are on the Little Ararat at 11,500 ft.; flowering specimens 5–7 high were here gathered, 12/24 August, 1871. This species descends to about 3000 ft., and then reaches the height of 20–25 cm. [8–10 in.], as, for instance, in the Borshom range of mountains.

GENTIANA PYRENAICA, *Linn.* On Kasbek to fully 10,000 ft., and on Schah-dagh to close upon 11,000 ft.

*GENTIANA VERNA, *Linn.* On the Little Ararat it reaches to near the summit, that is more than 12,000 ft., which is my highest station. The specimens from that place, on 12/24 August, 1871, were past flowering, almost stemless, with strong rosettes of root-leaves, and the upper surface of the leaves much wrinkled. Specimens were gathered at 10,000 ft. which retained the flower-stalks of the previous year, 10 cm. high [4 in.]. I have this species from all the alpine localities of my sphere of travel, for instance, from Kapudschich at 10,000 feet.

*MYOSOTIS SYLVATICA, *Hoffm.* With Trautvetter and Koch I unite with this *M. alpestris*, Lehm., which with regard to vertical distribution embraces an uncommonly wide territory. Whether it grows at the sea-level, I am not able to state: I found it both in the Colchis and Talysch lowlands, but certainly it grows from 1000 ft. upwards, till it attains its greatest altitude on the Great Ararat of 14,000 ft., as certified by two dwarf specimens obtained 9/21 August, 1871. I must dispute the statement which Boissier makes (Fl. Orient. iv. 237) that *M. sylvatica* is only an annual, both forms under consideration being perennial. I gathered specimens of extraordinary vigour, which had flowering-stems of 20–25 cm [8–10 in.] on Küp-göl on 8/20 August, 1871. I find no essential difference in the hairiness of the individuals from various localities. The specimens from the previously mentioned station of 14,000 ft. are 7 cm. [2¾ in.] high and in full bloom; the radical leaves have long peduncles, are broadly oval, the lower cauline leaves almost clavate, the hairiness is somewhat weaker and more sparse than in specimens growing at lower altitudes.

ERITRICHUM NANUM, *Vill.* I have this plant only from Elbruz and Kasbek; on the former I found it 7 cm. [2¾ in.] high, at 10,000 ft., in flower, 10/22 August, 1865.

*SCROPHULARIA MINIMA, *Bieb.*, belongs only to the alpine region from Kasbek eastwards in the Great Caucasus. The maximum altitude of its occurrence is on the Azunta at 11,700 ft., 5/17 July, 1876; I gathered fine blooming specimens on Kurwa at 10,700 ft., and on Kwawlos at over 10,000 ft., 10/22 July, 1876, mostly out of flower. The comparatively stout root goes deep in the loose, damp slaty rubbish; the above-ground part of the plant rarely rises above 8–10 cm. [$3\frac{1}{8}$–4 in.].

SCROPHULARIA RUPRECHTI, *Boiss.* Fl. Orient. iv. 410, was found by Ruprecht in Daghestan at 10,000 ft.

VERONICA PETRÆA, *Stev.* I gathered my highest specimens in the Iohe Pass at 10,000 ft., 10/22 June, 1885.

VERONICA TEUCRIUM, *Linn.*, var. INTEGERRIMA, *Trautv.* I found this on Sawalan and the Bingöl-dagh at 10,000 ft. The variety ANISOPHYLLA ascends on Alagös up to a like altitude.

*VERONICA TELEPHIIFOLIA, *Vahl*, = *V. minuta*, C. A. Mey. (it has nothing to do with *V. orbicularis*, Fisch.; Boiss. Fl. Orient. iv. 450). After Trautvetter's example, I join both the above specifically named forms in one. I have a large series from all parts of the scene of my journeys. It attains its greatest elevation on the north-west side of Elbruz at 12,000 ft., on the Great Ararat at more than 13,000 ft., and on Schah-dagh at 12,000 ft.

VERONICA GENTIANOIDES, *Vahl.* The specimens which I got at fully 11,000 ft. at Küp-göl are still 12 cm. [5 in.] high, but those which were found on Kerigo at 10,500 ft. are a little smaller.

VERONICA BILOBA, *Linn.* I have this species from Kapudschich, where it occurred at 10,000 ft.

EUPHRASIA OFFICINALIS, *Linn.* Tiny dwarfs in full flower only 10–15 millim. [$\frac{1}{2}$–$\frac{3}{4}$ in.] in height were collected on Kwawlosmta, 10/22 July, 1876; they were also obtained 7 cm. in height from Aschich-dagh, where they grow on heathery slopes, 20 July/10 August, 1871. The former form accords well with *E. minima*, Schleich.

PEDICULARIS CAUCASICA, *Bieb.* From Pirli-dagh, 27 June/9 July, 1885, thrifty specimens as much as 12 cm. [5 in.] in height in full flower. I brought examples of this species from quite 10,000 ft. on Alagös, which were 7–10 cm. [$2\frac{3}{4}$–4 in.] high. I

venture to assign its highest station on Sawalan at 11,000 ft. Ruprecht and Owerin report this plant in its white-flowered variety at 10,000 ft. from Daghestan.

*PEDICULARIS CRASSIROSTRIS, *Bunge,* is united by Boissier (Fl. Orient. iv. 488) with *P. araratica,* Bunge. Trautvetter considers them distinct. I give the following information as regards *P. crassirostris:* I collected it on the Nussa Pass at 11,000 ft,, and still it was 12 cm. [5 in.] high, flowering 13/25 June, 1885; the same also on the northern side of Alagös in June 1875. Those which were found on the southern side, 20 July/1 August, 1875, were only 7 cm. [2¾ in.] high, and came from close upon 12,000 ft. Specimens from Elbruz, at 8000 ft., have flower-stems of 25 cm. [10 in.].

*PEDICULARIS ARARATICA, *Bunge.* On the ascent from Küp-göl to the north side of the Great Ararat, on 9/21 August, 1871, this plant was found in solitary specimens at fully 14,000 ft. It was in fruit, and the ripe capsules stood on stalks of 2–3 cm. [1–1¼ in.] high.

PEDICULARIS NORDMANNIANA, *Bunge,* I have from Borbalo at 10,000 ft.

*NEPETA SUPINA, *Stev.* The specimens from Küp-göl are nearly 30 cm. [11⅝ in.] in height; those which were gathered on Azunta, 5/17 July, 1876, immediately under the pass, at nearly 12,000 ft., were growing more underneath the slate-rubbish than above it. The part above ground extended only 10–12 cm. [4–5 in.] in height, whilst I was unable to get to the end of the main root.

SCUTELLARIA ORIENTALIS, *Linn.*, var. ALPINA, *Boiss.* Fl. Orient. iv. 682. Brought from Palänteken at nearly 10,000 ft., and from the Little Ararat at 11,000 ft.; the strong, tough creeping root bore a peduncle of 2 cm. [1 in.] high, with two flowers, Palänteken, 2/14 August, 1871. The specimen from Little Ararat was past flowering. I have specimens from the lowlands near Lenkoran, so that it occurs from the sea-level to 11,000 ft.

*LAMIUM TOMENTOSUM, *Willd.,* = *L. alpestre,* Trautv. Specimens are before me from most of the high alpine points in our region. On 10/22 August, 1865, I collected the extreme specimens on the north side of Elbruz at 12,000 ft., where

they overtopped the ground only 7–10 cm. [2¾–4 in.] and flowered. At Küp-göl this species attains a height of 30 cm. [11⅝ in.], but for the most part lay prostrate. I also found it in the Iohe Pass at 10,500 ft. The specimens from Schalbus came from 11,000 ft. Those from Kerigo at 10,600 ft. are interesting; their above-ground portion is weak and delicate, 7–10 cm. [2¾–4 in.] in height, lying in turf-like clumps, each clump arising from a common main root, which reaches 60 cm. [23¼ in.] in an undivided state, and then separates into its component fibres. The end of the root of a specimen in this Museum is the thickness of a crow-quill, and is there broken off; nevertheless it measures 37 cm. [14⅝ in.].

Plantago saxatilis, *Bieb.* The only one of this genus which ascends into the alpine zone, was collected by me on Schalbus and on Schah-dagh up to 10,000 ft., 7–10 cm. [2¾–4 in.] high. Haussknecht cites its occurrence in the north of Persia as high as 13,000 ft.; Boiss. Fl. Orient. iv. 881.

Oxyria digyna, *Hill,* = *O. reniformis,* Hook. Brought from Bingöl-dagh at fully 10,000 ft., and from Great Ararat at 11,000 ft.

Polygonum Bistorta, *Linn.* Ascends as high as the moist sedge and grass plots attain, which in the Armenian highlands often occur at 11,000 ft.

Merendera Raddeana, *Regel,* by that author considered a distinct species, is very close to *M. caucasica,* Bieb.; but the latter takes in a broad zone, as according to Boissier (Fl. Orient. v. 168) it occurs close to the snow in the south of Persia, and has also been collected at the level of the Caspian Sea. My specimens of *M. Raddeana* were gathered in close proximity to the melting snow, on Sawalan at 11,000 ft., on 20 June/2 July, 1880.

Lloydia serotina, *Salisb.* I collected this on Kerigo and Archotis-mta at over 10,000 ft., 7–8 cm. [2¾–3⅛ in.]. in height.

Gagea Liottardi, *Sternb.* Gathered in the Suanian Alps on Laschchrasch at 10,000 ft., 11/23 June, 1880.

Gagea minima, *Schult. f.* Collected on 20 June/2 July, 1880,

on Sawalan at 10,000 ft.; the specimens were 15 cm. [6 in.] in height.

Gagea pusilla, *Schult. f.* The series of specimens in the Museum only certifies to one high alpine station, namely, the eastern foot of Kapudschich, where it was collected in company with *Puschkinia* in springy ground at nearly 10,000 ft., on 15/27 June, 1871.

Gagea reticulata, *Schult. f.* I dug up this species from soft, marly, calcareous soil close to the melting snow on the south side of Schah-dagh, at quite 11,000 ft., on 27 June/9 July 1885.

Ornithogalum refractum, *Waldst. & Kit.* This species lies before me from the Talysch lowlands, as well as from two alpine localities: on the 20 June/2 July, 1880, on Sawalan at more than 10,000 ft., and from the bottom of Kapudschich on 15/27 June, 1871, at about 9500 ft. The scape of the former is at most 2–3 cm. [1–1¼ in.] high.

Puschkinia scilloides, *Adam*, collected from 10,000 ft. on both Sawalan and Kapudschich.

Luzula spicata, *Linn.* Distributed in the alpine districts as far as the *Carex* turf-patches extend upwards. I gathered it at the altitude of 10,000 ft. on Borbalo, when it was 16–25 cm. [6½–10 in.] high, 15/27 July, 1876, also on Kerigo, 8/20 July, 1876; westwards on the Great Caucasus, especially on its south side and naturally dependent on the relative snow and cultivation lines, being thus like alpine plants in general. On Dadiasch strong specimens were met with at 9000 ft., on Elbruz at 10,000 ft., 11/23 August, 1865, the individuals 7–10 cm. [2¾–4 in.] high, and similar plants from Küp-göl at over 11,000 ft.

Luzula campestris, *Linn.*, var. alpina, *E. Mey.* I brought this form only from Elbruz at 10,000–11,000 ft., on 10/22 August, 1865. All other localities lie in the subalpine zone of 7000–8000 ft., in the middle and outer ranges.

Luzula multiflora, *Ehrh.*, var. congesta, *Boiss.* Fl. Orient. v. 349. Cited by Ruprecht from Daghestan at 10,000 ft.

Elyna schœnoides, *C. A. Mey.*, = *E. spicata*, Schrad.?, and a plant which Trautvetter named *E. humilis*, C. A. Mey.; all

three ascend high in the region of alpine Carices. The last plant, whose probable specific identity with *E. spicata* I cannot here decide, was found in dwarf specimens on Schah-dagh, at 12,000 ft., in flower, with peduncles 2–4 cm. [1–1⅝ in.] high, on 27 June/9 July, 1885.

·CAREX OREOPHILA, *C. A. Mey.* In the western part of the Great Caucasus to 9000 ft., according to C. A. Meyer; in the eastern to upwards of 10,000 ft., according to Ruprecht.

CAREX STENOPHYLLA, *Wahlenb.* This species is reported from the south of Persia and the main range of Afghanistan at 10,000 ft., Boiss. Fl. Orient. v. 400. Our herbarium possesses specimens collected by Owerin from the Daghestan Alps.

CAREX ATRATA, *Linn.* I gathered plants of this on Kerigo at 11,000 ft., 8–12 cm. [3⅛–5 in.] in height on 8/20 July, 1876. In the subalpine zone it grows more than 30 cm. high. C. LEPORINA, *Linn.*, also ascends into the alpine region.

CAREX SUPINA, *Wahlenb.* Cited by Ruprecht from Azunta at 9500 ft., Boiss. Fl. Orient. v. 415; the like with C. RIGIDA, *Good.*

CAREX TRISTIS, *Bieb.* The specimens gathered in the way to Küp-göl on the Great Ararat, on 8/20 August, 1871, are very robust, with flower-stems 30 cm. [11⅝ in.] in height. Ruprecht gives the altitude of this plant in Daghestan as 9600 ft., but that is certainly not its maximum.

PHLEUM ALPINUM, *Linn.*, occurs at 11,000 ft.; according to Boiss. Fl. Orient. v. 484, as high as 12,000 ft. in Afghanistan; specimens from Archotis-mta at 10,000 ft. have a height of 30 cm. [11⅝ in.].

*ALOPECURUS VAGINATUS, *Willd.* On Sawalan at 11,000 ft., 20 June/2 July, 1880; the specimens collected at the highest altitude had culms of 8–12 cm. [3⅛–5 in.] in height. Recorded by Ruprecht and Rehmann from the Great Caucasus at 10,000 ft., and I gathered it on Kerigo at the same elevation. The plant which Trautvetter described as a distinct species, *A. dasyanthus*, and united by Boissier (Fl. Orient. v. 489) to *A. vaginatus* as var. *unipaleaceus*, is also truly alpine. Near Küp-göl at over 11,000 ft. the specimens were still very strong, but above this

I could only trace the plant as occurring in small patches up to 12,000 ft. At that altitude the specimens from the Little Ararat, collected on 12/24 August, 1871, were only 5 cm. [2 in.] in height of culm.

Alopecurus glacialis, *C. Koch*,=*A. gracilis*, Trautv. Recorded by Ruprecht from Daghestan at 11,000 ft. (Boiss. Fl. Orient. v. 489).

Agrostis vulgaris, *With.* Recorded by Ruprecht from Daghestan at 10,000 ft. (Boiss. Fl. Orient. v. 515); the same with *A. lazica*, Bal.

Catabrosa Balansæ, *Boiss.* Ruprecht brought this from Daghestan at 10,500 ft. (Boiss. Fl. Orient. v. 577).

Catabrosa fibrosa, *Trautv.* I found this species, which stands very near the previous one, at Küp-göl at 11,300 ft., 8/20 August, 1871.

Catabrosa (Colpodium) versicolor, *Stev.* Recorded by Ruprecht from Daghestan at 10,500 ft. (Boiss. Fl. Orient. v. 579).

Poa annua, *Linn.*, embraces the wide zone from the sea-level to upwards of 10,000 ft.; specimens gathered on Sawalan at close upon 11,000 ft. were 10–12 cm. [4–5 in.] in height, 20 June/2 July, 1880.

Poa pratensis, *Linn.*, in its variety angustifolia, *Trautv.*, ascends above Küp-göl on the Great Ararat, thus more than 11,000 ft., and there throws up a stem of 20–30 cm. [8–11$\frac{5}{8}$ in.] in height.

Poa alpina, *Linn.*, I possess from Kasbek at 10,000 ft., 5–7 cm. [2–2$\frac{3}{4}$ in.] high; Ruprecht found it at similar elevations.

Poa attenuata, *Trin.*, to which Boissier (Fl. Orient. v. 609) unites *P. aratica*, Trautv., was gathered by me 30 cm. [11$\frac{5}{8}$ in.] in height at Küp-göl at fully 11,000 ft., 20–9/21 August, 1871.

Festuca ovina, *Linn.*, in its subspecies sulcata, *Hack.*, was collected by me on Sawalan at 11,000 ft., and I also have the forms brunnescens and violacea, *Gaud.*, which have well-developed roots, and are 8–12 cm. [3$\frac{1}{8}$–5 in.] in height. The variety Ruprechtii, *Boiss.* Fl. Orient. v. 619, was reported from

Borbalo by Ruprecht at 10,000 ft.; the variety REMOTA, *Hack.*, reaches in Afghanistan the altitude of 14,500 ft. (Boissier).

FESTUCA RUBRA, *Linn.*, subsp. VIOLACEA, *Hack.*, at Küp-göl attains the height of 30 cm. [$11\frac{5}{8}$ in.].

BROMUS ERECTUS, *Huds.* Only from Bingöl-dagh and from Sawalan at 10,000 ft.

BROMUS VARIEGATUS, *Bieb.*, var. PUBESCENS, *Trautv.*, I found at Küp-göl, on 9/21 August, 1871, at 11,000 ft., 30 cm. [$11\frac{5}{8}$ in.] in height.

A Sketch of the Vegetation of British Baluchistan, with Descriptions of New Species. By J. H. LACE, Esq., F.L.S., Deputy Conservator of Forests in India, assisted by W. BOTTING HEMSLEY, F.R.S., A.L.S., Principal Assistant at the Herbarium, Royal Gardens, Kew.

[Read 14th December, 1890.]

(PLATES XXXVIII.-XLI. & MAP.)

INTRODUCTION.

WHILE stationed in Baluchistan, my attention was drawn by Dr. G. Watt, C.I.E., to the fact that the Flora of the country was incompletely known, and in consequence I endeavoured to make as complete a collection of the plants as possible, which, though commenced on a small scale in 1885, was chiefly carried out during 1887 and 1888. I now propose to lay before the Society an account of the collection; but before entering into the subject of the composition of the vegetation, it will be well to say a few words regarding the geography, physical features, and climate of the country.

The districts of Sibi and Peshin were ceded to the British in 1879 by the Treaty of Gandamak, and were first of all known as the Assigned Districts of Southern Afghanistan, but now the whole country included in the Baluchistan Agency is called British Baluchistan, and of this the Bolan and Quetta valleys alone form part of Baluchistan proper, and for the occupation of these latter districts rent is paid to the Khan of Kelat. The

accompanying sketch-map shows the position of the principal places of the country; and my botanical collections were made within the tract of which the extreme corners are Chaman on the west, Sibi on the south, and Anambar on the east—that is to say, over an area of some 7000 sq. miles.

Physical Features.

The country is divided into two main drainage areas, the watershed between which is formed by an irregular line of limestone and conglomerate hills, running from a little east of Quetta to north of Kach, and then taking an abrupt turn to the east to Spirarágha. The area to the west is much the smaller of the two, and is drained by what is known as the Peshin Lora (Lora being the local name for river), the principal tributaries of which are the Bárshor Lora, the Surkhab Lora, which starts from the watershed at the head of the Zhob valley, and the Kákar Lora, which receives the drainage of the Gwál and Quetta valleys. The larger area to the east is divided into many valleys by ranges of limestone running more or less east and west; the drainage finding its way in a southerly direction through the rifts, so that eventually the streams of the Bori, Thal-Chotiáli, Kawás, Shahrag, Hurnai, and Sangán valleys find their way into the Nári river, the greater part of whose water is diverted where it debouches from the hills, for irrigating the lands round Sibi, the surplus continuing to flow down the Nári until it eventually loses itself in the desert.

Sibi is situated at the north end of the "Pat," or desert, which extends from Jacobabad, and is 500 feet above sea-level. A short distance beyond Sibi the first hills are entered, and the country rises rapidly in a series of rough and irregular ranges, between which are high valleys, such as Quetta (5500 ft.), Peshin (5000 ft.), Thal (3000 ft.), Bori (4000 ft.), and Shahrag (4000 ft.). The ranges often attain 10,000 ft.; and the highest peak, 11,700 ft., is on Zarghun, a huge mass of conglomerate a few miles east of Quetta; while Khalipat above Shahrag, and Takatu north of Quetta, both ranges of hard limestone, are only slightly less elevated.

Although there are many large river-beds, and the country is much intersected by water-courses, these are for the most part dry during the greater part of the year, or only contain small perennial streams; but many of them become torrents at the time of heavy rains.

Geology.

The geological formation of the country consists chiefly of Cretaceous rocks, the highest and most extensive ranges being composed of a hard limestone, occasionally of conglomerate, and the Khwája Amrán range of shales. Trap rocks crop out here and there between the ranges; for instance, between Kach and Kán, at an elevation of 7000 ft. In the lower hills sandstones and marls are common, and the hills near Khattan, where petroleum springs are being worked, are particularly rich in fossils.

The soil immediately below the high ranges is usually dry and stony. In the middle of the Quetta valley it is somewhat clayey, and in the Peshin plain consists principally of a deep, sandy loam. In some localities, as at Sharigh, the soil is apparently the produce of old swamps, and is black and poor in quality and often waterlogged. A great deal of land in this country, particularly in the Peshin district, contains various salts, some of which appear as efflorescence on the surface after the land has been irrigated, or after the winter rains.

The principal mineral products of the country are coal and petroleum. The coal exists in small seams in various parts, and is being worked at Khost near Shahrag, and at Gandak, a few miles north-east of Quetta. Petroleum wells have been sunk at Khattan, sixty miles east of Sibi, and the oil is being at present used for railway works at the Khojak tunnel. Petroleum has been also found in other parts of the country; but the borings are often interfered with and sometimes have to be abandoned owing to the enormous quantities of hot mineral water that are encountered.

Climate.

The climate of Baluchistan is remarkable for its extremes and rapid changes of temperature, being, at an altitude of 3000 ft. and upwards, much more severe than at similar altitudes in the Himalayas. At Quetta the shade temperature sometimes reaches 105° F., while in winter it falls below zero. In the Peshin valley in June I have experienced a difference of over 50° F. between day and night temperatures in a tent; whereas at Sibi or in the Punjab plains, at the same season, there would be little difference between them. These extremes are probably in great part due to the scanty vegetation of the country, bare hills, and almost

total absence of forest-growth, causing a very rapid radiation of heat.

Situated in the arid zone, the rainfall is naturally small, that at Quetta for eleven years, 1878–1888, being only 8·9 in., whereas at Peshin it is very much less, and sometimes at Sibi there is not an inch of rain during the year. In the juniper tracts at Ziarat and on the high ranges the fall of rain and snow is much greater than at lower altitudes, but no record has hitherto been kept in such localities. At Quetta the rainy season is from January to April, the rainfall of March being greatest on the average (2·1 in.), and again in July and August there are usually short and comparatively heavy storms, but the average falls for those months do not reach an inch.

Owing to the hills being so poorly clothed with vegetation, the water runs off extremely rapidly, flooding the main river-beds in an amazingly short time. These floods often attain several feet in height in the Bolan and Hurnai rivers, which for a short period become raging torrents, carrying everything before them.

Vegetation of Baluchistan.

Prefatory Remarks by Mr. Hemsley.

About two years ago Mr. Lace informed me that he was botanizing British Baluchistan and forming a herbarium, and requested my assistance in the determination of such of the plants as he and Dr. G. Watt and Mr. Duthie were unable to name with the resources at their disposal in India. He also sent the whole of his herbarium to Kew for verification. This has been done, not to the very fullest extent critically, but sufficiently for all practical purposes, and the few species that appeared to be new have been described. There still remains a small residuum of undetermined species, due either to the insufficiency of the material or to the want of time to work out large genera.

The special interest of this collection is that it represents with greater fulness than has hitherto been done the flora of a given area of the Afghan region. It is true that this very same area has been traversed in the south-western part and botanized by

several travellers, but nobody had previously exhaustively examined the flora, or anything approaching it.

In 1839 William Griffith accompanied the military expedition to Afghanistan, and passed through the western border of the country botanized by Mr. Lace, through the Bolan pass, Quetta, and Kila Abdulla to Kandahar; and he must have collected most assiduously all along the route, judging by what has since been accomplished.

The Afghan Delimitation Commission of 1884–5, to which Dr. J. E. T. Aitchison was attached, followed the same route as far as Quetta, and then proceeded westward; and the botanical results of this expedition are given in the third volume of the second series of the Transactions of this Society.

In 1850–1, Dr. J. C. Stocks made several excursions from Sind into Baluchistan, and botanically explored a parallelogram of the country to the south-west of Quetta, situated between the meridians 66 and 67 and the parallels of latitude 28° and 30°. He did not publish a complete enumeration of the plants collected; but he contributed a short though graphic sketch of the vegetation to Hooker's 'Kew Journal of Botany' *, and subsequently described many of the novelties in succeeding volumes of the same serial.

Dr. Aitchison's contributions to the botany of Afghanistan in the eighteenth and nineteenth volumes of the Journal of the Society will be fresh in the memories of many Fellows. The country explored by him lies two or three degrees to the north of the Quetta region, and yielded a much larger proportion of novelties.

This is the sum of what is known of the flora of the region under consideration.

Vegetation. (By Mr. Lace.)

General Remarks.

My collection of plants contains about 700 species, the great majority of which are herbaceous; trees and shrubs being few in number in Baluchistan. The following are the natural orders most abundantly represented, with the number of plants collected belonging to each:—

* Vol. ii. (1850), pp. 303–308.

N. O.	No. of Species.	Percentage of whole Collection.
Compositæ	81	11·5
Gramineæ	70	10·0
Leguminosæ	66	9·4
Cruciferæ	48	6·8
Labiatæ	35	5·0
Chenopodiaceæ	24	3·4
Boragineæ	23	3·3
Liliaceæ	23	3·3
Caryophylleæ	20	2·8
Rosaceæ	20	2·8

The hills and plains, which for the greater part of the year look brown and barren, are covered in the spring, from March to May, with a vast number of flowering plants; small for the most part, but many of them brilliantly coloured, thus totally changing the general appearance of the country. The most common colour of the flowers is yellow, and purple comes next.

The Flora is remarkably rich in Cruciferæ compared with the Himalayas, about Simla for example; also in the number of *Astragali*, which are chiefly spring plants. A marked feature of the vegetation of the country is the number of spinous plants that are found. Even cultivated species when they do not get sufficient moisture become spiny—the common apricot, for instance; but the majority of these spinous plants belong to the Compositæ, which natural order forms 11½ per cent. of the total vegetation, and to the genus *Astragalus*.

Although the grasses are very numerous, a large proportion of them are annuals and soon die down when the weather becomes hot, some of them coming up again late in the year on irrigated land; but generally speaking good fodder grass is not abundant, *Andropogon laniger* being the only species which covers large tracts of land.

Out of the 700 species collected eleven only appear to be new to science, though a few others remain undetermined. In the following paragraphs the composition of the vegetation is given of well known and distinct geographical areas.

Vegetation of the Plains at Sibi.

The vegetation in the neighbourhood of Sibi is similar to that of part of the Punjab plains and Sind; the uncultivated land

producing a fairly thick jungle of *Prosopis spicigera*, *Salvadora oleoides*, and *Capparis aphylla*. In the low-lying lands, within the influence of floods, the above are replaced by *Tamarix articulata* and *T. gallica*, amongst which *Populus euphratica* has been introducing itself to a small extent during the last few years, the seed of this species being brought down by floods from the Thal-Chotiali district.

Amongst the most noticeable shrubs are:—*Zizyphus nummularia*, which differs from the type chiefly in having a fleshy scarlet fruit; *Calotropis procera*, very abundant in this arid region, growing to a large size, and is used for making sword-scabbards; *Acacia Jacquemontii*, *Calligonum polygonoides*, *Crotalaria Burhia*, *Leptadenia Spartium*, and *Taverniera nummularia*, very characteristic of the sandy and shingly soil; and *Physorrhynchus brahuicus*, a large round bush, four feet high, locally common, and the largest of the Cruciferæ found in Baluchistan.

Alhagi Camelorum is very abundant, and differs from that species when growing at higher altitudes, in Peshin for instance, in being much taller and having a greater number of leaves. *Rhazya stricta* (Apocynaceæ), an erect, stout, gregarious shrub, two feet in height, is quite characteristic of the dry stony watercourses, and covers large areas in the Bolán, extending also up the Hurnai route to 4000 ft. *Ærua javanica*, *Pluchea lanceolata*, *Fagonia arabica*, *Tribulus alatus*, *Trianthema pentandra*, *Mollugo Glinus*, *Limeum indicum*, *Cressa cretica*, *Eclipta erecta*, on the banks of watercourses, *Solanum Dulcamara*, *Plantago amplexicaulis* and *Spergularia*, in corn-fields, and *Cassia obovata*, the senna-plant, are some of the most abundant herbaceous plants. Amongst salsolaceous plants, *Haloxylon recurvum* (from which a crude carbonate of soda is manufactured), *H. multiflorum*, *Suæda vermiculata*, and *Salsola fœtida* cover large areas of land impregnated with salts, and form, with *Salvadora* and *Tamarix*, the chief camel-fodders. On the roots of *Salvadora oleoides* a very handsome parasite, *Cistanche tubulosa*, having golden-coloured flowers, is found.

Of the grasses *Panicum antidotale*, called by the natives "Gum," is the most important, often forming large bushes with the lower stems woody, and is considered a good fodder. *Eleusine flagellifera* and a species of *Eragrostis* are perhaps the most abundant grasses in fields and cultivated ground.

The only tree cultivated by the people near their villages until recently seems to have been *Zizyphus Spina-Christi*; but of late

years a considerable number of trees of *Acacia arabica* have been raised from seed in the fields round Sibi.

Vegetation of the Hurnai Railway route.

On leaving Sibi and proceeding up the Hurnai route the outer hills are almost, if not quite, destitute of vegetation, and in the valleys leading off on either side of the Nari river there is little beyond a few miserable bushes or trees of the same species as noted at Sibi. Between Spintangi (2000 ft.) and Sunerai, *Vitex Agnus-Castus* is met with for the first time, and this gregarious shrub, with a tall species of *Aristida* and *Saccharum ciliare*, are the characteristic plants of the dry, stony watercourses up to about 4500 ft., beyond Shahrag. Up to 3000 ft. *Acacia Jacquemontii* occurs with the above, and *Nerium odorum*, deadly poisonous to camels, is found near water up to 6000 ft.

In cultivation at Hurnai, *Dalbergia Sissoo, Olea europæa, Morus alba*, and a few *Prosopis spicigera* trees are found; the two former of which will be treated of under "Forests." On the surrounding stony ground *Periploca aphylla* is abundant, affording fodder for camels and fuel for the people; *Zizyphus nummularia, Z. oxyphylla, Gymnosporia montana*, and *Capparis aphylla* also occur, and a few miserable shrubs of *Acacia modesta*; this being the western limit of the last-named shrub.

A little below Hurnai the dwarf-palm, *Nannorrhops Ritchieana*, commences to form dense thickets, which reach their maximum extent at Shahrag, where they cover many acres of ground. I may mention in passing that immense quantities of its leaves are cut yearly for making mats and ropes. This palm extends up to 5500 ft., and is common on the rocks in the Wáni and Mehráb rifts, and at the base of the low hills. The date-palm is rare.

On the low hills and stony, flat ground in this region many species of herbaceous plants and grasses are found, amongst which may be mentioned:—*Farsetia Jacquemontii, Malcolmia strigosa, Polygala Hohenackeriana*, in the shade of rocks, *Viola cinerea*, in the nála-beds, *Argyrolobium roseum, Citrullus Colocynthus, Psammogeton biternatum, Astericus pygmæus, Picridium tingitanum, Solanum gracilipes, S. xanthocarpum*, and several species of *Plantago*. In or near cultivated land, *Althæa Ludwigii* and *Fumaria parviflora* are common; on the banks of irrigation-channels, *Lippia nodiflora*; and hanging down from the perpen-

dicular stony sides of dry watercourses *Cocculus Leæba* is often seen, sometimes associated with *Ochradenus baccatus* and *Pulicaria glaucescens.*

Many grasses are represented, though few occur in abundance, except *Andropogon laniger*, which often covers large tracts on the lower hills. Other common species are: *Andropogon Schœnanthus, A. annulatus, Heteropogon hirtus, Pollinia eriopoda, Tristachya Stocksii*, and *Eleusine scindica.*

On reaching the Shahrag plateau (4000 ft.), eighteen miles from Hurnai, there is a change in the climate. Although very hot in summer, snow falls there occasionally in winter, and many plants, such as *Dalbergia Sissoo, Vitex Agnus-Castus, Zizyphus*, &c., which thrive well 500 ft. lower down, reach their limit. At Shahrag, *Merendera persica*, with clusters of white, pink, or violet flowers, is very abundant in February, and a little later on the fields are often full of the common purple *Iris Sisyrinchium.*

After passing through the Chappar rift (5000 ft.), two miles in length, in which *Leontice leontopetalum, Crambe cordifolia, Echinops Griffithianus, Crepis fœtida, Salvia pumila*, and *Euphorbia osyridea* are common, the railway passes into the Mángi valley at 5200 ft. In the bed of the Mángi stream *Nerium odorum* and small bushes of *Tamarix gallica* are the prevalent plants; and on the neighbouring hills *Juniperus macropoda* occurs in a more or less stunted form. *Caragana ambigua* and *Othonnopsis intermedia* are common, and in a few places *Capparis spinosa* occurs. During the summer *Carthamus oxyacantha* is abundant locally, and *Psammogeton biternatum* extends over considerable areas; and this is the lowest point at which *Perowskia abrotanoides* is found. In the swampy grass-land *Typha angustifolia* is plentiful.

Opposite to, and a short distance from, the Chappar, is the Pil rift, a narrow gorge rising to 6500 ft., at the entrance to which are a few bushes of *Rubus fruticosus*, a very uncommon shrub, which is said, however, to occur in some of the ravines of the Khwája Amrán range.

Vegetation from Hurnai to Loralai.

About five miles N.E. of Hurnai one of the rifts, so common in the ranges of limestone of British Baluchistan, is reached, through which passes the Military road to the Bori valley. Along this route the flora is wonderfully rich in species, at least for Baluchistan,

which is very likely due to a more abundant rainfall than the more western parts of the country receive, though there are no available records of the quantity. At the entrance to the gorge *Sida rhombifolia* was found, which is noteworthy as being the first *Sida* recorded from Baluchistan; and close by *Ruellia patula* occurred, the only species belonging to the Acanthaceæ that was collected in the country. Most of the plants already mentioned as occurring near Hurnai are represented for some distance up the rift. *Dalbergia Sissoo* extends up to 4000 ft., and near water *Nerium odorum* is common, *Ficus virgata* occasional, and in shady places *Asplenium Capillus-Veneris* grows luxuriantly, while *Pteris longifolia* is rare. The precipitous hills on each side of the rift are dotted with *Olea europæa*; near and above Torkhán (4700 ft.) and Dilkúna, *Pistacia Khinjak* and *P. mutica* var. *cabulica* are very common; *Celtis australis* is less abundant and usually much hacked about for feeding sheep and goats. *Dodonæa viscosa* is very abundant above 3500 ft., its upper limit seeming to be about 5000 ft.; usually gregarious, this species is sometimes mixed with *Gymnosporia montana*, *Vitex Agnus-Castus*, *Rhamnus persicus*, and *Prunus eburnea*, and grows best just out of the reach of floods.

In the clefts of the limestone rocks a few small bushes of *Ehretia obtusifolia* were occasionally seen, and on the edges of the ravines *Lantana alba* and *Abutilon bidentatum*. The dwarf-palm, too, is frequent. *Myrsine africana*, a common Himalayan and African shrub, is rarely met with. There were a few small bushes of it a little below Torkhán, at 4500 ft., but I have not seen it elsewhere.

A shrubby form of *Prunus Amygdalus* occurs here, and, unlike the cultivated species, so frequent in the Quetta and Gwál valleys, flowers at the same time or after the leaves come out. It is found at Torkhán, above Dilkúna, and in other parts of the country further north, such as the Pil rift, behind the Khalipat range, &c., and may be the wild form of *P. Amygdalus*. The branches are generally lopped by the shepherds for feeding their herds, and in such cases curious long shoots spring up in the centre of the shrubs on which there are a few narrow, linear leaves, entirely different from the normal ones, and in this it again differs from the cultivated species, whose coppice-shoots bear normal leaves.

In early spring one of the most striking shrubs is *Prunus*

eburnea, having silvery-white young branches and pink flowers, which appear before the leaves. This shrub becomes very common between 4500 and 8000 ft., and forms dense thickets in many places. At this time of the year *Caragana ambigua* is also conspicuous by its deep yellow flowers; and *Astragalus Stocksii*, with pale yellow flowers, is common. Other common shrubs are *Rhamnus persicus* and *Sageretia Brandrethiana*.

Among the smaller plants, *Primula Lacei* is one of the most interesting, being the only *Primula* found hitherto in Baluchistan, and it is only locally abundant in the clefts of limestone rocks in shady situations at about 4500 ft. *Statice Griffithii* and *Euphorbia osyridea* are characteristic of the precipitous rocky ground; the latter a perennial called "Barrar," the milky sap of which is used to coagulate milk. *Tulipa chrysantha*, with bright yellow petals, sometimes tinged on the outside with a reddish brown, is very common on the hills in this region; *Asparagus capitatus* frequently occurs near the sides of ravines; and during the spring several species of small Cruciferæ and Leguminosæ appear.

The road after passing through the Torkhán and Dilkúna rifts continues to ascend gradually up to about 7000 ft.; the hills on every side being sprinkled here and there with olive and pistachio trees. It then descends to the Smalan-Sinjawi valley (5000 ft.), where the myrtle groves are the most attractive feature. These groves are very dense, about fifteen feet high, covering small areas amongst the fields, and have been greatly reduced in size from time to time to make room for cultivation. The age of the trees must be considerable, and similar groves do not occur elsewhere in British Baluchistan.

Proceeding on to Loralai and descending to 4000 ft., there is a general absence of tree-growth, and little vegetation to be seen except in the spring, when a great number of small annuals put in an appearance. In the Bori valley there are numerous orchards near the villages, in which the principal tree is the apricot, though mulberry-trees are common.

Vegetation of the Quetta Valley.

The Quetta valley, running due north and south, is about fifteen miles long by four miles wide in its southern half, broadening out at the north end to eight miles, and is bounded on the

north by the Takatu range, on the east by Murdár, and on the west by the Chihiltan range, having an outlet in the N.W. corner which leads into the valley of the Kákar Lora. Except at the foot of the Chihiltan range, where there is a good number of pistachio-trees, the hills surrounding the valley have been denuded of the only trees (juniper and pistachio) to supply Quetta with firewood, and for the greater part of the year have an extremely barren appearance. In the spring, however, these hills are fairly covered with herbaceous plants belonging to the orders Cruciferæ, Leguminosæ, Compositæ, Boragineæ, and Liliaceæ.

Throughout the valley, near all villages, are numerous orchards, the most valuable of which are surrounded by high mud walls, and have a belt of *Populus alba* or mulberry-trees planted on the inside to protect the apricot, almond, peach, pear, and apple trees from the wind. In these orchards the pomegranate and fig are often grown as underwood, so to speak, and vines are either grown in deep trenches or allowed to climb over the mulberry-trees. The large-leaved mulberry cultivated in Europe is often grafted on stocks of *Morus alba*. *Elæagnus angustifolia*, called locally "Sinjit," is often raised from cuttings. Its fruit has a woolly, insipid taste, but is nevertheless appreciated by the people, and in the autumn the leaves of this tree are given to sheep and goats. *Salix acmophylla* is often grown on the banks of water-channels, and is frequently used to form barriers in the beds of streams, so as to regulate their courses and prevent erosion of the banks.

The climate of the Quetta and Peshin valleys is eminently suited to fruit-growing, but the people hitherto have grown little besides apricot-trees, which yield a small fruit that is dried for winter use or for export to India. Grapes and peaches are the best fruits grown by the people. Excellent peaches, apples, pears, and plums have been produced during the last ten years from English grafts, and a number of fruit-trees grafted in Kandahar have been imported into Peshin.

Since the British occupation much has been done in planting avenues of various species of *Populus* and *Salix*, also *Platanus orientalis*, along the roads, slips of which plants were originally obtained from Kandahar by Mr. H. S. Barnes, late Political Agent of Quetta and Peshin. *Populus alba* has done very well, and it may be worth mentioning that, although many of the trees are now of considerable size and some produce male catkins, the

majority are apparently female trees, and during the time I was in Quetta (more than five years) I did not succeed in finding a single one of the latter with catkins on it.

Ranunculus falcatus is one of the first small plants to appear in the spring, and, with *Poa bulbosa*, often covers the greater part of the ground in orchards during March. *Iris Stocksii* on the hills, and *I. Sisyrinchium*, *Ixiolirion montanum* and *Hyacinthus glaucus* in the fields, with *Muscari racemosum* near the irrigation-channels, are very abundant. *Tulipa chrysantha* is abundant everywhere, though when growing in cultivated ground it has larger flowers of a pure yellow colour. In deep soil *Bongardia Rauwolfii* is one of the most common early plants, and occurs elsewhere up to 7000 ft.

Eremurus persicus, having white flowers, salmon-coloured on the outside, covers large tracts of stony ground, growing two to four feet high, and is usually associated with *E. aurantiacus*, whose young leaves are eaten by the Pathans as a vegetable, and whose flowering-stalks sometimes attain six feet in height.

One of the most striking plants in the spring is *Sophora Griffithii*, its bright yellow flowers appearing before the leaves, although higher up, at 8000 ft., the flowers and leaves often appear together. On the lower slopes of the hills *Convolvulus leiocalycinus*, a stiff, spinous shrub, two feet high, with pure white flowers, is conspicuous and is characteristic of the more stony ground. Many *Astragali* are represented, the majority small plants with purple or yellow flowers. Later on in the year *Sophora alopecuroides* covers large areas wherever the soil is deep, and is very common in the fields. *Othonnopsis intermedia*, a woody gregarious shrub, of the Compositæ, two feet high, is also very characteristic of the Quetta valley, though it extends up to 9000 ft. Its native name is "Gungu," and it is said to be very poisonous to camels, and is used medicinally by the people; also a kind of tinder is made from its ash with cotton. Two species of *Artemisia* are exceedingly abundant in late summer.

In the swampy grass-lands, called "chamans," *Ononis hircina*, a small, erect, spiny undershrub with purple flowers *, *Ranunculus aquatilis* var. *trichophyllus*, *Lotus corniculatus*, *Lepidium crassifolium*, *Plantago major*, *Calamagrostis lanceolata*, *Phragmites communis*, and *Eragrostis cynosuroides* are the most common plants.

* In the 'Flora of British India' it is described as unarmed and as having reddish flowers.

In cultivated lands the following weeds are generally present:—*Adonis æstivalis* (of stouter habit and larger flowers than the Indian type); *Hypecoum procumbens*; *Fumaria parviflora*; *Malcolmia africana* (a very variable plant); *Sisymbrium Sophia*; *Lepidium Draba*; *Euclidium syriacum*; *Goldbachia lævigata*; *Chorispora tenella*; *Saponaria Vaccaria*; *Silene conoidea*; *Holosteum umbellatum*; *Malva rotundifolia*; *Erodium Cicutarium*; *Galium tricorne*; *Lithospermum tenuiflorum*; *Veronica agrestis*; and *Orobanche indica* (?). Along the banks of irrigation channels *Hyoscyamus reticulatus*, *Centaurea iberica*, *Cichorium Intybus*, and *Alopecurus pratensis* are very frequent, and occasionally *Xanthium Strumarium*. Growing in running water is a variety of *Veronica Anagallis*. In corn-fields *Centaurea depressa* and *C. Picris* are often found. *Halocharis violacea*, a curious diffuse prostrate plant with minute reddish-purple flowers, occurs occasionally; and on the banks of the Lora, *Camphorosma monspeliaca*, though the latter is not so abundant as in certain parts of the Peshin valley.

In the karezes, or underground channels by which water is brought from the foot of the hills to the cultivation below, and by which means the greater part of the irrigation is carried out, *Asplenium Capillus-Veneris* grows most luxuriantly.

Vegetation of the Kákar Lora Valley.

Leaving the Quetta valley at the N.W. corner, the valley of the Kákar Lora is entered, sometimes called the Gwál valley. This is separated from the Quetta valley by the Takatu range, the highest point of which is 11,400 ft., and from the Peshin valley by a number of low hills composed chiefly of red clay. Most of the species found about Quetta extend to the Kákar Lora valley, but there are some changes in the vegetation; for instance, the two species of *Sophora* become less and less frequent towards the north, until they cease altogether at Peshin.

This valley is chiefly covered with *Artemisia* and *Alhagi Camelorum*, the latter the well-known camel fodder, which is cut and collected by the Pathans in this and the Peshin valley during the autumn. The thorny brushwood is collected into heaps and beaten into small pieces, winnowed slightly, and stored for winter use.

Towards Gwál, between 5500 and 6000 ft., *Ephedra pachyclada* covers a good many acres, though, owing to being constantly

browsed by herds of sheep and goats, it is only occasionally more than a few inches high. It is curious that this species does not extend either to Quetta or Peshin.

Between Ulgai and Gwál, the stony ground at the base of the hills, and the hills between Gwál and the Surkháb valley, are dotted with trees of *Pistacia mutica*, var. *cabulica*; but this tract is chiefly remarkable for the presence of *Stocksia brahuica*, a stiff spinous shrub, 6 to 12 ft. high, with scanty foliage and yellow flowers produced in April to May, usually before the leaves appear. Its fruit, like a brownish-grey pea, is enclosed in an inflated bag of a brilliant yellowish-red colour. This locality appears to be the southern limit of this shrub. Another characteristic plant of this region is *Ebenus stellata*. *Prunus eburnea* also occurs, and *Delphinium persicum*, *Onobrychis dealbata*, *Crucianella glomerata*, *Campanula Griffithii*, a species of *Acantholimon*, *Paracaryum asperum*, *Onosma stenosiphon*, *Convolvulus leiocalycinus*, *Salvia spinosa*, and *Euphorbia densa* are amongst the most common plants. In the beds of dry watercourses *Microrhynchus spinosus*, a leafless spiny member of the Compositæ, is very characteristic of poor sandy soil.

Vegetation of the Peshin Valley.

The Peshin valley is roughly 36 miles long from east to west, and 15 miles broad; it is much intersected by watercourses with perpendicular banks, sometimes 50 to 80 ft. high, but in which there is little water except during the time of floods. The elevation varies from 5200 to 4500 ft. Between these watercourses there are extensive plains, a very small part of which is cultivated, owing to want of water. Two irrigation schemes lately completed have enabled some thousands of acres to be cultivated that formerly could only be utilized occasionally for rain-crops; but still the greater part of the valley must always remain uncultivable either from insufficiency of water or on account of the salts in the soil.

Many of these plains are covered for miles with bushes of *Artemisia* and *Haloxylon Griffithii*, the root-stocks of which constitute the chief fuel of certain villages in the winter, and their twiggy, leafless branches seem all that the flocks of sheep and goats have to feed upon during that season. The smoke from the wood of the *Artemisia* is said to be very injurious to the eyes, but the wood of *Haloxylon Griffithii* is rather prized by blacksmiths for making charcoal.

In the western part of the valley there are several thousand acres covered with a variety of *Tamarix gallica*, which is usually cut down by the people every second or third year for fuel or for making mats used in roofing houses; yet, if left to grow, this species becomes a fair-sized tree, 20 to 30 feet high, with a trunk over 7 feet in girth. Examples of such trees can be seen on the north side of the valley, where there are some sacred groves. This tamarisk often flowers twice in the year, once in March and April before the leaves appear, and again in September and October. In these jungles very few plants are found; the most striking being a large *Orobanche* with purple flowers, which appears as a parasite on the roots of the tamarisk. *Camphorosma monspeliaca* is occasionally abundant in saline soil amongst the tamarisk bushes, and *Cousinia tenella* is common beneath them, while *Asparagus monophyllus* occurs as a climber.

In saline soil, very frequent towards the west, *Atriplex leptoclada*, *Suædæ*, *Salsola lanata*, *S. verrucosa*, and *Halocharis sulphurea* grow luxuriantly.

During March and April the ground is carpeted with small flowers; *Papaver cornigerum*, with bright scarlet flowers, and the daisy-like heads of *Matricaria lasiocarpa* are the most abundant and conspicuous. The order of Cruciferæ is largely represented, most of them small, unimportant-looking plants, but which no doubt account in a great degree for the excellent condition of the sheep. Of the Cruciferæ, *Malcolmia Bungei* and *Cheiranthus Stocksianus* are the most striking, though both are rather local in sandy soil; several species of *Alyssum* and *Isatis minima* are abundant, and sheep and goats seem very fond of the last, also of *Cheiranthus Stocksianus*.

A very minute form of *Ranunculus falcatus*, often barely half an inch high, is extremely plentiful early in the spring, usually under *Artemisia* and other small bushes. There are many species of *Astragalus*, of which the most noteworthy are *A. auganus*, *A. kahiricus*, and *A. hyrcanus*; and *Onobrychis tavernieræfolia*, whose seed-pod remains adherent to the root after germination, is common in sandy soil. *Eremostachys thyrsiflora*, a handsome plant, one to two feet high, is common on gravelly soil, and *Arnebia linearifolia* is abundant everywhere.

Carex physodes forms a turf in many places, and is much grazed by sheep and goats when it first shoots up. In the fruiting-stage this sedge is very conspicuous, owing to its large

brown-coloured inflated utricles. *Eremurus persicus* covers large areas on the low hills between Bostan and Yaru Karez, also at Peshin; *E. velutinus*, a species that I did not find in the Quetta valley, being also locally abundant at the latter place. *Iris falcifolia*, with smoky-purple flowers, is common about Yaru Karez; and another *Iris* (no. 3593), with very long flower-stalks, growing in dense clumps with coir-like fibres surrounding the root-stocks, is very abundant in sandy soil at Peshin. *Tulipa montana*, having extremely handsome, deep red flowers, is most conspicuous on certain hills up to 6500 feet, and so is the small *Fritillaria Karelinii*.

Othonnopsis intermedia occurs gregariously, and *Calligonum polygonoides* is common, while in the driest ravines are often seen straggling bushes of *Lycium barbarum*, called by the natives "Karghanna," the name they also give to *Stocksia brahuica*, the latter only occurring under the hills at the S.E. corner of the valley. *Zygophyllum atriplicoides*, a shrub with green-winged fruits, is found in a few places, and is most abundant in stony ravines about Kach at 6500 ft. A *Cousinia* (=Stocks 930, and Griffith 3323) is another of the gregarious plants characteristic of the east end of the valley; *C. bipinnata* is generally abundant, and its leaves are considered excellent fodder for horses.

In the Surkháb valley, a few miles due E. of Peshin, a variety of *Clematis orientalis* grows on the tamarisk bushes. The flowers are generally solitary, with long slender axillary-jointed peduncles, which sometimes produce a lateral flower; and the leaves are often pinnately decompound, with narrow linear segments, occasionally toothed.

Most of the grasses in the valley are annuals, and several species of *Bromus*, *Poa*, and *Hordeum* are abundant; while *Cynodon Dactylon* only occurs on the banks of irrigation channels, near water or on cultivated land.

The Khwája Amrán range lies on the west side of the Peshin valley. It is composed chiefly of shales, and is dotted with trees of *Pistacia mutica*, var. *cabulica*, which are chiefly abundant in the stony beds of the numerous ravines. *Tulipa montana*, *T. chrysantha*, and *Iris ensata* are the most striking plants on these hills; and *Draba Hystrix*, a species that I have not found elsewhere, occurs in small clumps. A species of *Lonicera* was found near the top of the Khojak Pass, but no specimens were obtained in flower or fruit; bushes of *Prunus eburnea*, *Caragana*,

and *Cotoneaster* are common, and beneath them are found *Delphinium uncinatum* and *Anemone biflora*. *Thalictrum minus* is usually found here and on other ranges in deep soil between rocks and in the shade of bushes from 6000–9000 ft. *Leptaleum hamatum*, a new species, is a common herb on soil formed of the disintegrated shales.

Vegetation of the Juniper Tracts.

Under this head may be included the vegetation from 7000 to 10,000 ft., and embraces the country round Ziarat, the Pil range, and the Zarghun range near Quetta. The most important and abundant species is *Juniperus macropoda*, named "Obúsht" by the Pathans and "Appurz" by the Baluchis. It forms forests of considerable extent, and is usually pure, being rarely mixed with *Pistacia mutica*, var. *cabulica*, or with *Fraxinus xanthoxyloides*, and only occasionally attains tree size, owing to the unmerciful way in which its branches are lopped for feeding sheep and goats; and *Celtis caucasica* is in the same category. The shrubs are numerous, and of these *Prunus eburnea* is perhaps the most abundant, forming thickets on stony ground between the ranges up to 9000 ft.; the fruit ripens yellow like an apricot, bursts open longitudinally, and soon afterwards the seed falls to the ground. *Lonicera quinquelocularis* grows to a considerable size, 18 to 20 ft., in favourable localities; and *L. hypoleuca*, *Abelia triflora*, *Daphne oleoides* (poisonous to camels), *Ephedra nebrodensis* ?, *Caragana ambigua*, *Berberis vulgaris* and *B. Lycium* (usually near water), *Spiræa brahuica* on the rocks, *Rosa Beggeriana*, *Cotoneaster nummularia* (sometimes with shining, and at other times with tomentose leaves), *Ribes orientale* (occurring up to 11,000 ft.), *Buddleia paniculata*, *Salvia cabulica*, and *Berchemia lineata* (characteristic of the limestone rocks) are usually common, and to a lesser extent *Jasminum humile*, *Ficus Carica*, *Rhamnus persicus* (whose bark yields a red dye), *Sageretia Brandrethiana*, and *Prunus microcarpa* ? *Jasminum pubigerum* and *Viburnum cotinifolium*, var., differing from the type by its retuse leaves, are both rare. Amongst other less important shrubs are *Sophora Griffithii*, *Plectranthus rugosus*, and *Othonnopsis intermedia*.

Colutea armata, a new species, is a curious decumbent spiny undershrub with inflated pods. It rarely grows to any size,

owing to it being browsed by sheep and goats, and has only been found at Ziarat and on the Pil hill from 7500 to 9000 ft. Its native name is "Taháwan."

In many places amongst the juniper tracts small maidáns are met with from 9000 to 10,000 ft., which are covered with hummocks of *Acantholimon Munroanum*, *A. fasciculare?*, and *Onobrychis cornuta*; and in the midst of these or under the shade of bushes *Gypsophila lignosa*, a new species, is often found. In other places these small elavated plains are covered with *Cousinia scala*, a biennial, whose leaves in a young state are grazed by sheep and goats.

Perowskia abrotanoides is very abundant, and often forms hedges on the borders of fields at elevations of from 8000 to 9000 ft. Large bushes of *Clematis asplenifolia* are found locally, growing in the clefts of limestone rocks in gorges; and in the gorge above Zandra the new *Saussurea rupestris* was discovered, growing in small clumps; but this species does not appear to be very common. *Clematis graveolens* is a characteristic climber of these parts of the country.

The most characteristic small plants on the limestone cliffs about Ziarat are *Aitchisonia rosea*, *Bupleurum falcatum*, *B. exaltatum*, *Pimpinella* sp. (no. 3874), *Peucedanum* sp. (3993), *Rubia infundibularis*, Hemsl. & Lace. *Scutellaria petiolata*, Hemsl. & Lace, having violet flowers and similar to *S. grossa*, but having a more woody stem, slenderer flowering stems, and slenderly petiolate few-toothed or entire leaves, is a native of this region.

Under the shade of the juniper trees *Viola kunawarensis* is abundant, and differs from that species as described in the 'Flora of British India' by its white flowers streaked with purple in the centre only; also the altitude at which it is found, 7000 to 10,000 ft., is much lower than that given as its distribution, viz. 11,000 to 15,000 ft. *Leptorhabdos Benthamiana* (Scrophularineæ) is another frequent plant in the shade of trees or rocks, and is considered excellent fodder for sheep and goats. It has a wide range, being found from 3500 to 10,000 ft.

During the spring many plants belonging to the Liliaceæ are found that occur at lower altitudes, such as *Eremuri*, *Irides*, *Allia*, *Merendera persica*, &c. *Hibiscus Trionum* and *Centaurea Picris* are characteristic of cultivated ground.

Many grasses are represented, among which a species of *Agropyrum* (? *A. junceum*, var.), called "Wijz" by the people, has the

reputation of being the best fodder in the country. Next in importance are *Pennisetum orientale* (up to 7000 ft.), *P. flaccidum*, *Stipa capillata* and another species, *Oryzopsis cærulescens*, and *Andropogon Bladii*. *Melica Jacquemontii* is a frequent grass amongst bushes, and seems to have a poisonous effect on all animals that eat it. The Pathans call it "Lawanai butaey." I have seen camels seized with a kind of paralysis of the hind quarters after eating this grass; but whether it was caused by the grass itself or by the larvæ of some insect that I found very abundant in the roots at certain periods, I was unable to determine; yet as the bad effect on the animals takes place very rapidly, it is probably the grass itself.

Of the six ferns found in British Baluchistan, *Asplenium Ruta-muraria* and *Cystopteris fragilis* are fairly abundant near Ziarat, and more rarely *Cheilanthes Szovitzii*, while on Zarghun *Asplenium viride* was found.

The vegetation on Zarghun is very similar to that about Ziarat at the same altitudes, but in the gorge at the head of the Hanna Valley, 15 miles N.E. of Quetta, an interesting new thorn, *Cratægus Wattiana*, was found. This is a very uncommon tree, 15 ft. in height, which was only occasionally seen on the conglomerate formation of the Zarghun range. At 9000 ft. on the same range *Tulipa Biebersteiniana* occurs in the shade of bushes, and I did not find it elsewhere. A very handsome striking plant, abundant on the lower slopes and about Kach, is *Salvia Hydrangea*; its magenta-coloured flowers are used medicinally by the Pathans.

Very rare on the hills about Quetta, but fairly abundant locally on the stony lower slopes of some of the ranges further east, is *Vitis persica*, a stunted gregarious bush, two to three feet high.

Forests.

The juniper, *Juniperus macropoda*, is the only tree which forms forests of any extent, the best of them situated some sixty miles east of Quetta, in the neighbourhood of Ziarat, and extending over more than 200 square miles of country. There also remain a few square miles of juniper on the Zarghun range, but in this direction a great deal has been destroyed to keep Quetta supplied with fuel for the troops and public works. The juniper usually exists in open forest. Trees with clean boles are

very rare, and they are generally branched from the base; the lowest branches being often buried in leaf detritus near the trunk, and their extreme ends taking an upward turn, give them the appearance of young trees surrounding the old one. The trees often take the most fantastic shapes, their branches being gnarled and twisted in every direction, and when their main shoots have been cut off many feet from the ground, which is often the case, they assume a candelabra shape.

The growth of the juniper is very slow, yet it attains twenty feet in girth and occasionally seventy feet in height. Although it reproduces itself from seed, very few of the seedlings survive, owing chiefly to climatic conditions. The wood is light, has little strength, and burns quickly, and is employed extensively in building, principally for rafters; but it is even more extensively used for fuel. The bark is of immense thickness at the base of old trees, and is taken off in long pliant strips by the Pathans, who use it for roofing their huts. A kind of liquid called "Doshah" is prepared from the fruit, and the fruit is also employed in curing skins.

Pistacia mutica var. *cabulica* is common on some of the arid, stony hills and in dry watercourses, from 4000 to 7500 ft., for instance at Gwál, Dozán in the Bolan Pass, at the base of the Chihiltán and Mashalak ranges, on the Khwája Amrán, near Anambar, and in other localities. At the last-named place it has grown up in the midst of large bushes or small trees of *Acacia modesta*, the latter affording it protection from being grazed by camels, sheep, and goats; and this may well be called the meeting point of the typical trees of the low hills of Baluchistan and the Panjáb. This Pistachio-tree never forms forests, but is usually gregarious, or scattered at intervals over the ground, the very best portions being somewhat like a very open orchard. It attains 20–25 feet in height and 6–10 feet in girth; and the short and clean bole is surmounted by a large, ample crown, the outline of which is almost semicircular in a well-grown tree. The wood is very hard, dark, and finely grained, and is a most excellent firewood, in fact the best in the country. The fruit, called "Shnee," only abundant every third year, is much prized by the people. This species is easily distinguished from *P. Khinjak*, which usually occurs as a shrub in clefts of limestone rocks between 5000 and 6000 ft., or near Hurnai as a tree 20 feet high, much branched from the base, by its leaves and its

bark. The bark of *P. Khinjak* is light grey in colour on the exterior and reddish brown inside, and is smooth and exfoliating, whereas that of *Pistacia mutica* var. *cabulica* is dark brown with longitudinal fissures. The two species are distinguished by the natives, who call *P. Khinjak* "Ushgai" or "Buzgai," and *P. mutica* var. *cabulica* "Gwan" (Baluchi), "Khanjak" (Peshin), "Badwan" (Hurnai). These native names are worth recording, because evidently *P. Khinjak* received its name from "Khanjak," though in Boissier's 'Flora Orientalis' the description of that species corresponds to what the people call "Ushgai," and that of *P. cabulica* with the real "Khanjak."

The common olive is another small gregarious tree, scattered over larger areas than the Pistachio, and usually at a lower altitude, its range being between 2500 and 6500 feet. It is abundant in the ravines and sheltered situations on the south side of the Khalipat range, on the cliffs of the Wám and Mehráb rifts, and it is said that there are some very fine groves of it in the Zhob valley.

Between the Wám rift and Hurnai, at 3500 feet, a broad stony, usually dry watercourse is covered with a curious mixture of tree-growth, forming a fairly thick jungle. The chief element is *Dalbergia Sissoo*, which attains some size, and this is mixed with *Tecoma undulata*, *Olea*, and *Pistacia*; the principal underwoods being *Dodonæa viscosa*, *Grewia oppositifolia*, *Periploca aphylla*, *Gymnosporia montana*, *Rhamnus persicus*, *Zizyphus oxyphylla*, and *Sageretia Brandrethiana*.

In the Thal-Chotiali district, along the banks of the Narechi river and in the Pujjha valley, *Populus euphratica* forms a fringe, with a belt of *Tamarix articulata* on each side, forming forest in places.

The forests of the plains have already been treated of under the vegetation of the Sibi neighbourhood.

Cultivation.

Since the British occupation of the country, the land brought under cultivation has greatly increased in extent, there being no fear nowadays of one tribe raiding on another, but owing to the small supply of water in the country, there is a limit to this extension, and in many parts the custom is to let the land lie fallow for one or two years.

In the Sibi district the principal grain crops are wheat, barley,

and various millets; a few vegetables, such as carrots and turnips, being cultivated near Sibi itself. Very small areas of cotton and some oil seeds are occasionally seen a few miles out of Sibi.

From Hurnia to Dargai a great deal of the land is placed under rice, and the highest elevation at which I have seen rice cultivated is in a sheltered rift at Kawás, at 7000 ft. Barley, wheat, and pulse are also grown.

In the higher valleys barley is the chief crop, especially in Peshin, and in favourable years considerable areas in the valleys and scattered about the hills, up to 9000 ft., are sown with barley, the crop depending upon the rainfall. Of the millets the most common probably is *Panicum miliaceum*, which is cultivated up to 8000 ft. Fine crops of Indian corn are grown about Quetta from seed imported from India; but a very stunted form of this corn, which is one of the staple foods of the people, is commonly grown in the valleys at elevations of from 5000 to 9000 ft.

Lucerne is largely grown, and is a most paying crop if freely watered and manured; four or five good crops per annum being frequent. A very heavy crop will yield 200 maunds per acre of green lucerne, but the average is between 100 and 150 mds.

Many varieties of melon, water-melon, and others are largely planted and yield excellent fruit.

In a few localities *Rubia tinctorum* is cultivated for dyeing purposes.

Fodders.

The fodder question is one of the most difficult in Baluchistan, since no great quantities of grass exist in the greater part of the country, and animals subsist chiefly on the straw of cereals. The expense incurred in consequence in feeding horses and transport animals is very great, and to lessen this in some degree I lately started, on behalf of the Commissariat Department, a fuel and fodder farm on land in connexion with one of the irrigation schemes in the Peshin valley; but owing to the climatic conditions it will take some time before it is properly established.

The best fodder at present available for horses is straw mixed with lucerne, but it is expensive, and grass, *Pennisetum orientale*, is only attainable at Quetta in small quantities from the neighbouring hills. "Dub" grass, *Cynodon Dactylon*, so abundant

in the plains of India, is only found along irrigation channels and in cultivation. Near Loralai, in the Bori valley, there is a better supply of grass. An area has been reserved by the Commissariat, and no doubt much might be done in reserving suitable areas for the growth of the natural grasses of the country.

At Sibi, *Panicum antidotale* is the most adundant fodder, and in the Juniper forests there is a good deal of a species of *Agropyrum* which is considered excellent fodder for horses and cattle.

The large herds of sheep and goats which roam over the hills for six or seven months of the year keep in excellent condition, and this is due to the numerous small Cruciferous and Leguminous plants which afford them excellent pasturage.

Lepidium Draba and *Convolvulus arvensis* are collected in large quantities at Quetta, from the borders of irrigation channels and from cultivated land, for feeding cattle.

Camels find abundant fodder generally in the Salsolaceous plants, *Alhagi Camelorum*, tamarisk, &c., and are very fond of grazing on most trees and on the berries of the juniper.

Indigenous Plants used for Food.

Several plants are eaten by the people as vegetables, the principal of which are the young leaves of *Eremurus aurantiacus*, *Lepidium Draba*, and *Chenopodium Botrys*. The bulbs of tulips (that of *Tulipa chrysantha* having a pleasant taste like a nut) and of *Iris Stocksii* are eaten, and also the fleshy rootstocks of *Tragopogon gracile* and *Scorzonera mollis*. The nut of *Pistacia mutica*, var. *cabulica*, is greatly relished, although very small compared with that of *P. vera* and with a strong flavour of turpentine. Amongst other fruits are those of *Olea europæa*, eaten chiefly as a medicine, the kernel of *Prunus eburnea*, *Berberis vulgaris*, *Berchemia lineata*, *Sageretia Brandrethiana*, and the fruit of *Astragalus purpurascens* called "Palez." In certain years a kind of manna is found on *Cotoneaster nummularia*, whose fruit is also eaten by the people. At Sibi the fruit of *Salvadora oleoides* is collected, and on the higher hills the caraway seed is collected in large quantities.

Plants used Medicinally.

A decoction from the mashed roots of *Berberis vulgaris* is said to be given for chest complaints. In case of fever many plants are considered efficacious; the most important being *Salvia Hydrangea*, the seeds of *Salvia spinosa*, *Thymus Serpyllum*, *Iphiona persica*, and the vapour given off from the seeds of *Peganum Harmala*. As purgatives, *Tanacetum gracile* and *Euphorbia Heyneana* are used, and for rheumatism infusions of the leaves of *Othonnopsis intermedia* and *Rhazya stricta*.

A solution for wounds is made from the roots of *Sophora Griffithii* and from the seeds of *Salvia spinosa*. The dried flowers of *Tulipa chrysantha* make a kind of jalap; and cooling drinks or medicines are made from *Perowskia abrotanoides*, *Otostegia Aucheri*, *Teucrium Stocksianum*, and from the root of *Cichorium Intybus*.

A kind of manna ("gúrrai") found on *Othonnopsis intermedia* is given medicinally to cattle; the leaves of *Plectranthus rugosus* are employed to kill ticks and other insects on sheep; and the pounded leaves of *Daphne oleoides* are used for wounds or sores on sheep.

Withania coagulans, *Mentha sylvestris*, and *Tribulus terrestris* are also used medicinally.

Conclusion.

In conclusion I have to thank Dr. George Watt, C.I.E., for the time and trouble he gave to my collection of plants, and it is due to him that it was made as complete as possible. My thanks are also due to Mr. J. F. Duthie, who named many of the Grasses; to Miss M. Smith, for careful drawings of some of the new species; and I am also deeply indebted to Mr. W. B. Hemsley, who so kindly undertook the final determination of the plants and the descriptions of the new or undescribed species, and who has been good enough to bring this paper before the Society.

List of the Vascular Plants collected in British Baluchistan.*
(By Messrs. Lace and Hemsley.)

Ranunculaceæ.

Clematis graveolens, *Lindl.*
— orientalis, *Linn.*, var.
— asplenifolia, *Schrenk.*
Anemone biflora, *DC.*
Thalictrum minus, *Linn.*
Adonis æstivalis, *Linn.*
Ranunculus aquatilis, *Linn.*, var. cæspitosus, *DC.*; (syn. R. cæspitosus, *Thuillier*, et R. trichophyllus, *Chaix*, var. terrestris).
— falcatus, *Linn.*
— arvensis, *Linn.*
Aquilegia vulgaris, *Linn.*, var.; (syn. A. Moorcroftiana, *Wall.*).
Delphinium persicum, *Boiss.*
— rugulosum, *Boiss.*
— orientale, *J. Gay.*
— uncinatum, *Hook. f. & Thoms.*
— sp. aff. D. saniculæfoliæ, *Boiss.*

Menispermaceæ.

Cocculus Leæba, *DC.*

Berberideæ.

Berberis vulgaris, *Linn.*
— Lycium, *Royle.*
Bongardia Rauwolfii, *C. A. Mey.*; (syn. Bongardia chrysogonum, *Boiss.*).
Leontice leontopetalum, *Linn.*

Papaveraceæ.

Papaver dubium, *Linn.*
— cornigerum, *Stocks.*
Glaucium frimbrilligerum, *Boiss.*
Rœmeria hybrida, *DC.*

Fumariaceæ.

Hypecoum procumbens, *Linn.*
Corydalis rupestris, *Kotschy.*
Fumaria parviflora, *Lam.*

Cruciferæ.

Mathiola odoratissima, *R. Br.*
Cheiranthus Stocksianus, *Boiss.*; (syn. Erysimum Stocksianum, *Boiss.*, et E. crassicaule, *Boiss. Fl. Or.* i. p. 199).
Nasturtium officinale, *R. Br.*
Arabis nuda, *Bélanger.*
Octoceras Lehmannianum, *Bunge.*
Farsetia Hamiltoniana, *Royle.*
— Jacquemontii, *Hook. f. & Thoms.*
Alyssum minimum, *Willd.*
— linifolium, *Steph.*
Psilonema dasycarpum, *C. A. Mey.* (= Alyssum).
Draba Hystrix, *Hook. f. & Thoms.*
Malcolmia africana, *R. Br.*
— Bungei, *Boiss.* (syn. M. circinnata, *Hook. f. & Thoms.*).
— torulosa, *Boiss.*
— strigosa, *Boiss.*
Sisymbrium Sophia, *Linn.*
— sp. near S. pannonicum, *Jacq.*
— sp.? (S. Loeselii, *Linn.*, simile.)
Conringia planisiliqua, *Fisch. & Mey.*
Erysimum repandum, *Linn.*
Leptaleum filifolium, *DC.*
— hamatum, *Hemsley & Lace*, n. sp.
Eruca sativa, *Lam.*
Capsella Bursa-pastoris, *Mœnch.*
— elliptica, *C. A. Mey.*
Lepidium sativum, *Linn.*
— Draba, *Linn.*
— Aucheri, *Boiss.*
— crassifolium, *Waldst. & Kit.*
Æthionema cristata, *DC.*
Clypeola echinata, *DC.*
— Ionthlaspi, *Linn.*
Isatis minima, *Bunge.*
— Stocksii, *Boiss.*
Pachypterygium heterotrichum, *Bunge.*
Tauscheria lasiocarpa, *DC.*
Neslia paniculata, *Desv.*
Euclidium syriacum, *R. Br.*
— tataricum, *DC.*
Crambe cordifolia, *Stev.*
Physorrhynchus brahuicus, *Hook.*
Raphanus sativus, *Linn.*
Goldbachia lævigata, *DC.*
Chorispora tenella, *DC.*

Capparideæ.

Capparis spinosa, *Linn.*
— aphylla, *Roth.*

* A number of undetermined species are not included in this enumeration.

RESEDACEÆ.

Reseda Aucheri, *Boiss.*
Oligomeris glaucescens, *Cambess.*
Ochradenus baccatus, *Delile.*

VIOLACEÆ.

Viola kunawarensis, *Royle.*
— cinerea, *Boiss.*

POLYGALEÆ.

Polygala Hohenackeriana, *Fisch. & Mey.*
— sibirica, *Linn.*

CARYOPHYLLEÆ.

Dianthus crinitus, *Smith.*
Acanthophyllum squarrosum, *Boiss.*
Gypsophila Honigbergeri, *Boiss.*
— Stewartii, *Thoms.*
— (§ Eugypsophila-Capitatæ) lignosa, *Hemsley & Lace*, n. sp.
Gypsophila alsinoides, *Bunge.*
Saponaria Vaccaria, *Linn.*
— orientalis, *Linn.* ?
Silene nana, *Kar. & Kir.*
— conoidea, *Linn.*
— Griffithii, *Boiss.*
— brahuica, *Boiss.*
Lychnis (§ Melandrium) cabulica, *Boiss.*
Holosteum umbellatum, *Linn.*
Cerastium dichotomum, *Linn.*
— inflatum, *Link.*
Stellaria crispata, *Wall.*
Spergularia rubra, *Pers.*
— diandra, *Guss.*
Arenaria Meyeri, *Boiss.*
— filiformis, *Labill.*; (syn. Alsine picta, *Boiss.*).

TAMARISCINEÆ.

Tamarix gallica, *Linn.*
— —, var. indica.
— articulata, *Vahl.*

MALVACEÆ.

Althæa Ludwigii, *Linn.*
Malva rotundifolia, *Linn.*
Sida rhombifolia, *Linn.*
Abutilon bidentatum, *Hochst.*
Hibiscus Trionum, *Linn.*

TILIACEÆ.

Grewia oppositifolia, *Roxb.*
— populifolia, *Vahl*, forma.
Corchorus trilocularis, *Linn.*

LINEÆ.

Linum perenne, *Linn.*, var. Stocksianum.
— strictum, *Linn.*

ZYGOPHYLLEÆ.

Tribulus terrestris, *Linn.*
— alatus, *Delile.*
Seetzenia orientalis, *Decne.*
Zygophyllum Fabago, *Linn.*
— atriplicoides, *Fisch. & Mey.*
— coccineum, *Linn.*
Fagonia arabica, *Linn.*

GERANIACEÆ.

Geranium rotundifolium, *Linn.*
Erodium cicutarium *Linn.*
— bryoniæfolium, *Boiss.*
Oxalis corniculata, *Linn.*

RUTACEÆ.

Ruta acutifolia, *DC.*
— erythræa, *Aitch. & Hemsley.*
— pedicellata, *Aitch. & Hemsley.*
— tuberculata, *Forsk.* ?
Peganum Harmala, *Linn.*
Tetradiclis salsa, *Stev.*

CELASTRINEÆ.

Celastrus spinosus, *Royle* (forma ramulis inermibus).
— senegalensis, *Lam.*

RHAMNEÆ.

Zizyphus Spina-Christi, *Lam.*
— nummularia, *Wight & Arn.*
— oxyphylla, *Edgew.*
Berchemia lineata, *DC.*
Rhamnus persicus, *Boiss.*
Sageretia Brandrethiana, *Aitch.*

AMPELIDEÆ.

Vitis persica, *Boiss.*
— vinifera, *Linn.*

Sapindaceæ.

Stocksia brahuica, *Benth.*
Dodonæa viscosa, *Linn.*

Anacardiaceæ.

Pistacia Khinjak, *Stocks.*
— mutica, *Fisch. & Mey.*, var. cabulica.

Leguminosæ.

Argyrolobium roseum, *Jaub. & Spach.*
Crotalaria Burhia, *Ham.*
Ononis hircina, *Jacq.*
Trifolium repens, *Linn.*
Trigonella Fœnum-græcum, *Linn.*
— polycerata, *Linn.*
— corniculata, *Linn.*
— sp. cfr. T. retrorsa, *Boiss.*
Melilotus parviflora, *Desf.*
— altissimus, *Thuill.*
Medicago lupulina, *Linn.*
— sativa, *Linn.*
— laciniata, *All.*
Lotus corniculatus, *Linn.*
Colutea armata, *Hemsley & Lace*, n. sp.
Tephrosia pauciflora, *Grah.*
Sesbania aculeata, *Pers.*
Caragana Gerardiana, *Royle.*
— ambigua, *Stocks.*
Astragalus ammophilus, *Kar. & Kir.*
— tenuirugis, *Boiss.*
— campylorrhynchus, *Fisch. & Mey.*
— auganus, *Bunge.*
— kahiricus, *DC.*
— anisacanthus, *Boiss.*
— hyrcanus, *Pall.*
— Amherstianus, *Benth.*
— ophiocarpus, *Benth.*
— tribuloides, *Delile.*
— ankylotus, *Fisch. & Mey.*; (an A. gracilipes, *Benth.*?).
— psilacanthus, *Boiss.*
— hippocrepidis, *Benth.*
— tephrosioides, *Boiss.*, var. ?
— verticillaris, *Bunge.*
— decemjugus, *Bunge.*
— anfractuosus, *Bunge.*
— strobiliferus, *Royle.*
— purpurascens, *Bunge.*
— polybotrys, *Boiss.*
— brahuicus, *Bunge.*
— bakaliensis, *Bunge.*
— corrugatus, *Bertol.*
— Hemsleyi, *Aitch. & Baker.*
— Stocksii, *Benth.*
Taverniera nummularia, *DC.*
Ebenus stellata, *Boiss.*
Onobrychis micrantha, *Schrenk.*
— cornuta, *Desv.*
— dealbata, *Stocks.*
— tavernieræfolia, *Stocks.*
Alhagi Camelorum, *Fisch.*
Hedysarum Wrightianum, *Aitch. & Baker.*
Vicia Griffithii, *Baker.*
Ervum Lens, *Linn.* (Lens esculenta, *Moench*).
Lathyrus inconspicuus, *Linn.*
Rhynchosia minima, *DC.*
Dalbergia Sissoo, *Roxb.*
Sophora alopecuroides, *Linn.*
— Griffithii, *Stocks.*
Cassia obovata, *Collad.*
Prosopis spicigera, *Linn.*
Acacia arabica, *Willd.*
— Jacquemontii, *Benth.*
— modesta, *Wall.*

Rosaceæ.

Prunus Amygdalus, *Baill.*, varietates; (syn. Amygdalus communis, *Linn.*).
— microcarpa, *C. A. Mey.*?
— armeniaca, *Linn.*
— divaricata, *Ledeb.*
— domestica, *Linn.*, var.
— persica, *Hook. f. & Thoms.*
— eburnea, *Aitch. et Hemsl.*
Spiræa brahuica, *Boiss.*
Rubus fruticosus, *Linn.*, var. R. discolor, *Weihe & Nees.*
Potentilla fragarioides, *Linn.*
— —, var. pumila.
— supina, *Linn.*
Rosa Beggeriana, *Schrenk.*
— anserinæfolia, *Boiss.*, var. glandulosa.
— Eglanteria, *Linn.*
Pyrus communis, *Linn.*
Cratægus oxyacantha, *Linn.*
— (§ Pleiostylæ) Wattiana, *Hemsley & Lace*, n. sp.
Cotoneaster nummularia, *Fisch. & Mey.*

Saxifragaceæ.

Ribes orientale, *Poir.*

Crassulaceæ.

Sedum adenotrichum, *Wall.*

Myrtaceæ.

Myrtus communis, *Linn.*

Lythraceæ.

Punica Granatum, *Linn.*

Onagraceæ.

Epilobium minutiflorum, *Haussk.*

Cucurbitaceæ.

Cucumis Melo, *Linn.*
Citrullus Colocynthis, *Schrad.*
— vulgaris, *Schrad.*
Corallocarpus velutina, *Hook. f.*

Ficoideæ.

Trianthema pentandra, *Linn*
Mollugo Glinus, *A. Rich.*
Limeum indicum, *Stocks.*

Umbelliferæ.

Eryngium carlinoides, *Boiss.*
Bupleurum falcatum, *Linn.*
— exaltatum, *Bieb.*
Carum Bulbocastanum, *Koch?*
— copticum, *Benth.*
Sium angustifolium, *Linn.*
Pimpinella, sp. indeterminata.
Scandix pinnatifida, *Vent.*
Fœniculum vulgare, *Gærtn.*
Ferula oopoda, *Boiss.*
— ovina, *Boiss.*, var. vel sp. aff.
Peucedanum macrocoleum, *Boiss.*
Zosimia absinthiifolia, *DC.*
Coriandrum sativum, *Linn.*
Caucalis latifolia, *Linn.*
Psammogeton biternatum, *Edgew*

Caprifoliaceæ.

Viburnum cotinifolium, *Don*, var.
Abelia triflora, *R. Br.*
Lonicera quinquelocularis, *Hardw.*
— hypoleuca, *Decne.*

Rubiaceæ.

Randia tetrasperma, *Roxb.*
Gaillonia eriantha, *Jaub. & Spach*
— (Jaubertia Aucheri, *Spach*).
Rubia cordifolia, *Linn.*
— tinctorum, *Linn.*
— infundibularis, *Hemsley & Lace* n. sp.
Galium Aparine, *Linn.*
— tricorne, *With.*
— setaceum, *Lam.*
Asperula humifusa, *Bieb.*, var.
Crucianella glomerata, *Bieb.*
Aitchisonia rosea, *Hemsl.*
Callipeltis cucullaria, *DC.*

Valerianeæ.

Valeriana dioica, *Linn.*
Valerianella diodon, *Boiss.*

Dipsaceæ.

Morina persica, *Linn.*
Scabiosa Olivieri, *Coult.*

Compositæ.

Vernonia cinerascens, *Schultz-Bip.*
Aster altaicus, *Willd.*
Brachyactis umbrosa, *Benth.*
Erigeron alpinus, *Linn.*
Pluchea lanceolata, *Oliver.*
— rufescens, *Benth.*
Filago germanica, *Linn.*
Phagnalon niveum, *Edgew.*
Gnaphalium luteo-album, *Linn.*
— pulvinatum, *Delile.*
Inula grantioides, *Boiss.*
Vicoa Pentanema, *Aitch. & Hemsl.*; (syn. Pentanema divaricatum, *Cass.*).
Iphiona persica, *Benth. & Hook. f.*
Pulicaria foliolosa, *DC.*
— gnaphalodes, *Boiss.*
— glaucescens, *Jaub. & Spach.*
Xanthium strumarium, *Linn.*
Eclipta erecta, *Linn.*
Achillea Santolina, *Linn.*
Anthemis odontostephanus, *Boiss.*
— Gayana, *Boiss.*; (syn. A. scaposa, *Gay MSS.*).
Matricaria lasiocarpa, *Boiss.*
Tanacetum gracile, *Hook. f. & Thoms.*
— macropodum, *Hemsley & Lace*, n. sp.
Artemisia scoparia, *Waldst.*
— stricta, *Edgew.*
— maritima, *Linn.*
— Tournefortiana, *Reichb.*
Asteriscus pygmæus, *Coss.* (=Odontospermum).
Senecio coronopifolius, *Desf.*
Othonnopsis intermedia, *Boiss.*
Echinops Griffithianus, *Boiss.?*
Cousinia Alepideæ, *Boiss.?*
— scala, *Aitch. & Hemsl.*
— onopordioides, *Ledeb.*
— minuta, *Boiss.*
— heterophylla, *Boiss.*
— tenella, *Fisch. & Mey.*

Cousinia bipinnata, *Boiss.*
Cnicus arvensis, *Hoffm.*, var.
Saussurea candicans, *C. B. Clarke.*
— rupestris, *Hemsley & Lace*, n. sp.
Ægopordon berardioides, *Boiss.* (Jurinea, *Benth. & Hook. f.*).
Jurinea variabilis, *Aitch. & Hemsl.*
— carduiformis, *Boiss.* (Outreya, *Jaub. & Spach*).
Tricholepis, sp. n. ?
Zoegea purpurea, *Fresen.*
Centaurea albispina, *Aitch. & Hemsl.*
— depressa, *Bieb.*
— picris, *Pall.*
— iberica, *Trev.*
— moschata, *Linn.*
— phyllocephala, *Boiss.*
Carthamus oxyacantha, *Bieb.*
Cichorium Intybus, *Linn.*
Kœlpinia linearis, *Pall.*
Garhadiolus papposus, *Boiss. & Buhse.*
Crepis (§ Barkhausia) fœtida, *Linn.*
— Stocksiana, *Aitch. & Hemsl.*
Phœcasium lampsanoides, *Cass.* (syn. Crepis pulchra, *Linn.*).
Pterotheca Falconeri, *Hook. f.*
Taraxacum officinale, *Wigg.*, var.
Gymnarrhena micrantha, *Desf.*
Lactuca Scariola, *Linn.*
— dissecta, *Don.*
— viminea, *Link.*
— persica, *Boiss.*
— (§ Brachyrhamphus) sp. ?
Picridium tingitanum, *Desf.*
Sonchus asper, *Vill.*
— oleraceus, *Linn.*
— maritimus, *Linn.*
Microrhynchus spinosus, *Benth.*
Tragopogon gracile, *D. Don.*
Scorzonera mollis, *Bieb.*, var. ?
— papposa, *DC.*
— mollis, *Bieb.*
— tortuosissima, *Linn.* ?
— laciniata, *Linn.*
Epilasia ammophila, *Bunge.*

Campanulaceæ.

Campanula Griffithii, *Hook. f. & Thoms.*
— cashmeriana, *Royle*, var.

Plumbagineæ.

Acantholimon longiflorum, *Boiss.*
— polystachyum, *Boiss.*
— fasciculare, *Boiss.* ?
— Munroanum, *Aitch. & Hemsl.*
Statice spicata, *Willd.*, var.
— cabulica, *Boiss.* = 1593 *Griffith.*
— Griffithii, *Aitch. & Hemsl.*

Primulaceæ.

Primula Lacei, *Hemsley & Watt*, n. sp.
Anagallis arvensis, *Linn.*
Samolus Valerandi, *Linn.*

Myrsineæ.

Myrsine africana, *Linn.*

Oleaceæ.

Jasminum humile, *Linn.*
— pubigerum, *D. Don.*
Fraxinus oxyphylla, *Bieb.* var.; (syn. F. rostrata, *Guss.*).
— xanthoxyloides, *Wall.*
Olea europæa, *Linn.*, var.

Salvadoraceæ.

Salvadora oleoides, *Decne.*

Apocynaceæ.

Rhazya stricta, *Decne.*
Nerium odorum, *Soland.*

Asclepiadeæ.

Periploca aphylla, *Decne.*
Calotropis procera, *R. Br.*
Cynanchum petrense, *Hemsley & Lace*, n. sp.
Pergularia pallida, *Wight & Arn.* ?
Leptadenia Spartium, *Wight.*

Loganiaceæ.

Buddleia paniculata, *Wall.* (syn. B. crispa, *Benth.*, var.).

Gentianaceæ.

Gentiana Olivieri, *Griseb.*

Boragineæ.

Ehretia obtusifolia, *Hochst.*
Heliotropium Eichwaldi, *Steud.*
— undulatum, *Vahl.*
Cynoglossum Wallichii, *G. Don.*
Caccinia glauca, *Savi.*
Paracaryum asperum, *Stocks.*
Echinospermum oligacanthum, *Boiss.*?
— Lappula, *Lehm.* ?
— lævigatum, *Kar. & Kir.*
Eritrichium strictum, *Decne.*, var.
Asperugo procumbens, *Linn.*
Gastrocotyle hispida, *Bunge.*

Nonnea nigricans, *DC.*
Myosotis stricta, *Link.*
Lithospermum arvense, *Linn.*
— terniflorum, *Linn.*
Arnebia linearifolia, *DC.*
— Griffithii, *Boiss.*
— (§ Macrotomia) inconspicua, *Hemsley & Lace*, n. sp.
Onosma echioides, *Linn.*, var.
— stenosiphon, *Boiss.*
Munbya cyanochroa, *Boiss.*

CONVOLVULACEÆ.

Convolvulus lineatus, *Linn.*
— leiocalycinus, *Boiss.*
— arvensis, *Linn.*
— microphyllus, *Linn.*, var.
Cressa cretica, *Linn.*
Cuscuta europæa, *Linn.* ?
— gigantea, *Griff.*
— planiflora, *Tenore.*

SOLANACEÆ.

Solanum nigrum, *Linn.*
— Dulcamara, *Linn.*
— gracilipes, *Decne.*
— xanthocarpum, *Schrad.*
Withania coagulans, *Dunal.*
— somnifera, *Dunal.*
Lycium barbarum, *Linn.*
Datura Stramonium, *Linn.*
Hyoscyamus pusillus, *Linn.*
— reticulatus, *Linn.*
Nicotiana rustica, *Linn.*

SCROPHULARINEÆ.

Verbascum erianthum, *Benth.*
Linaria cabulica, *Benth.*
— odora, *Bieb.*, var.
— vulgaris, *L.*, var.
Schweinfurthia sphærocarpa, *A. Braun.*
Scrophularia scabiosæfolia, *Benth.* ?
Herpestis Monniera, *H. B. & K.*
Veronica Anagallis, *Linn.*
— agrestis, *Linn.*
— biloba, *Linn.*
— macropoda, *Boiss.*
Leptorhabdos Benthamiana, *Walp.*
Pedicularis pycnantha, *Boiss.*

OROBANCHACEÆ.

Cistanche tubulosa, *Wight.*
Orobanche indica, *Ham.*
— hirtiflora, *Reut.* ?
— Stocksii, *Boiss.*

BIGNONIACEÆ.

Tecoma undulata, *G. Don.*

ACANTHACEÆ.

Ruellia patula, *Jacq.*

VERBENACEÆ.

Lantana alba, *Mill.*
Lippia nodiflora, *Rich.*
Vitex Agnus-Castus, *Linn.*

LABIATÆ.

Plectranthus rugosus, *Wall.*
Mentha sylvestris, *Linn.*
Thymus Serpyllum, *Linn.*
Hyssopus officinalis, *Linn.*
Perowskia abrotanoides, *Kiril.*
Salvia Sclarea, *Linn.*
— spinosa, *Linn.*
— cabulica, *Benth.*
— Hydrangea, *DC.*
— glutinosa, *Linn.*
— pumila, *Benth.*; (Perowskia sp., = *Aitch.* 22).
Nepeta glomerulosa, *Boiss.*; ex J. D. Hook. (= N. juncea, *Benth. ex Boiss.*).
— bracteata, *Benth.*
— linearis, *Royle*, var. ?
— Cataria, *Linn.*
Ziziphora tenuior, *Linn.*
— clinopodioides, *Bieb.*
Lallemantia Royleana, *Benth.*
Hymenocrater sessilifolius, *Benth.*
Scutellaria prostrata, *Jacquem.*, var.
— linearis, *Benth.*, var. ?
— Stocksii, *Boiss.*
— multicaulis, *Boiss.*
— petiolata, *Hemsley & Lace*, n. sp.
Marrubium vulgare, *Linn.*
Chamæsphacos brahuicus, *Aitch. & Hemsl.*; (syn. Tapeinanthus, *Boiss.*).
Stachys parviflora, *Benth.*
Lamium amplexicaule, *Linn.*
Otostegia Aucheri, *Boiss.*
Phlomis spectabilis, *Falc.*
— Stewartii, *Hook. f.*
Eremostachys acanthocalyx, *Boiss.*, var. ?
— thyrsiflora, *Benth.*

Eremostachys labiosa, *Bunge?*
— loasæfolia, *Benth.* (Perhaps the same as *E. Vicaryi*, Benth.)
Teucrium Stocksianum, *Boiss.*
Zataria multiflora, *Boiss.*

PLANTAGINEÆ.

Plantago major, *Linn.*, var.
— amplexicaulis, *Cav.*
— ciliata, *Desf.*
— decumbens, *Forsk.*

NYCTAGINEÆ.

Boerhaavia sp. indeterminata.

ILLECEBRACEÆ.

Herniaria hirsuta, *Linn.*
— —, var. incana.
Cometes surattensis, *Burm.*
Gymnocarpos fruticosum, *Pers.*

AMARANTACEÆ.

Amarantus polygamus, *Linn.*
Ærua javanica, *Juss.*

CHENOPODIACEÆ.

Chenopodium album, *Linn.*
— Botrys, *Linn.*
— Blitum, *Hook. f.*
Beta maritima, *Linn.*
Atriplex laciniata, *Linn.?*
— leptoclada, *Boiss. & Noë.*
— dimorphostegium, *Kar. & Kir.*
Atriplex, *cf.* A. Halimus & A. parvifolia.
Ceratocarpus arenarius, *Linn.*
Chenolea eriophora, *Aitch. & Hemsl.*
Kochia stellaris, *Moq.?*
Suæda vermiculata, *Forsk.?*
Haloxylon recurvum, *Bunge?*
— multiflorum, *Bunge?*
— Griffithii, *Bunge.*
Salsola Kali, *Linn.*
— fœtida, *Delile.*
— lanata, *Pall.*
— verrucosa, *Bieb.?*
Halocharis violacea, *Bunge.*
— sulphurea, *Moq.*
Camphorosma monspeliaca, *Linn.*

POLYGONACEÆ.

Calligonum polygonoides, *Linn.*
— aviculare, *Linn.*
— afghanicum, *Meisn.*
— Persicaria, *Linn.*
Rumex dentatus, *Linn.*
Atraphaxis spinosa, *Linn.*, var. sinaica.

THYMELÆACEÆ.

Daphne oleoides, *Schreb.*
Diarthron vesiculosum, *Fisch. & Mey.*

ELÆAGNACEÆ.

Elæagnus angustifolius, *Linn.*

EUPHORBIACEÆ.

Euphorbia cœladenia, *Boiss.*
— osyridea, *Boiss.*
— helioscopia, *Linn.*
— densa, *Schrenk.*
— Heyneana, *Boiss.*
— sp., near E. tenuifolia and E. leptocaulis.
— Chamæsyce, *Linn.*
Andrachne telephioides, *Linn.*
Chrozophora tinctoria, *Linn.*
Ricinus communis, *Linn.*

URTICACEÆ.

Ulmus campestris, *Linn.*
Celtis caucasica, *Willd.* (= C. australis, *Linn.*).
— australis, *Linn.*
Morus alba, *Linn.*
Ficus Carica, *Linn.*
— virgata, *Roxb.*
Parietaria judaica, *Linn.*

PLATANACEÆ.

Platanus orientalis, *Linn.*

JUGLANDEÆ.

Juglans regia, *Linn.*

SALICINEÆ.

Salix acmophylla, *Boiss.?* (= S. safsaf, *Forsk.?*).
— Caprea, *Linn.*
— babylonica, *Linn.*
— triandra, *Linn.*, var.?
— angustifolia, *Willd.?*
Populus euphratica, *Oliv.*
— alba, *Linn.*
— nigra, *Linn.?*

GNETACEÆ.

Ephedra pachyclada, *Boiss.*
— nebrodensis, *Tin.?*
— sp. aff. E. nebrodensi.

Coniferæ.

Juniperus macropoda, *Boiss.*

Irideæ.

Iris falcifolia, *Bunge.*
— Sisyrinchium, *Linn.*
— Stocksii, *Hemsley & Lace*; (syn. Xiphion Stocksii, *Baker*).
— ensata, *Thunb.*

Amaryllideæ.

Ixiolirion montanum, *Herb.*

Liliaceæ.

Asparagus capitatus, *Baker.*
— trichophyllus, *Bunge.*
— monophyllus, *Baker*?
Eremurus persicus, *Boiss.*
— aurantiacus, *Baker.*
— velutinus, *Boiss. & Buhse.*
Allium Stocksianum, *Boiss.*
— umbilicatum, *Boiss.*
— rubellum, *Bieb.*? (A. Griffithianum, *Boiss.*)
— sp. aff. A. Pallasii.
— sp., near A. oleraceum and A. carinatum.
— sp. an A. stricti, *Schrad.*, var. ?
Muscari racemosum, *Mill.*
Hyacinthus glaucus, *Baker.*
Asphodelus fistulosus, *Linn.*
Fritillaria Karelinii, *Baker.*
Tulipa montana, *Lindl.*
— Biebersteiniana, *Schultz.*
— chrysantha, *Boiss.*
Gagea persica, *Boiss.*
— reticulata, *Roem. et Schult.*
Merendera persica, *Boiss.*

Juncaceæ.

Juncus glaucus, *Ehrh.* ?
— acutiflorus, *Ehrh.*

Naiadeæ.

Potamogeton oblongus, *Viv.*
— perfoliatus, *Linn.*

Palmæ.

Nannorrhops Ritchieana, *Wendl.*; (syn. Chamærops Ritchieana, *Griff.*).

Typhaceæ.

Typha angustifolia, *Linn.*

Aroideæ.

Arisæma abbreviatum, *Schott.*

Alismaceæ.

Triglochin palustre, *Linn.*

Cyperaceæ.

Cyperus fuscus, *Linn.*
— lævigatus, *Linn.*
— pungens, *Boeckl.*
Scirpus lacustris, *Linn.*
— setaceus, *Linn.*
Carex cardiolepis, *Nees.*
— diluta, *Bieb.*
— physodes, *Bieb.*
— orbicularis, *Boott.*
— stenophylla, *Wahl.*
Schœnus nigricans, *Linn.*

Gramineæ.

Panicum antidotale, *Linn.*
— Crus-Galli, *Linn.*
— erucæforme, *Sibth.*
— sanguinale, *Linn.*
— miliaceum, *Linn.*
Setaria glauca, *Beauv.*
— viridis, *Beauv.*
— italica, *Beauv.*
Pennisetum orientale, *Pers.*
Gymnothrix flaccida, *Munro* (Pennisetum).
Erianthus Ravennæ, *Linn.*
Andropogon laniger, *Desf.*
— Schœnanthus, *Linn.*, var.
— (§ Gymnandropogon) Bladii, *Retz.*
— annulatus, *Forsk.*
Phalaris canariensis, *Linn.*
Heteropogon hirtus, *Pers.*, var.
Chrysopogon Gryllus, *Trin.*
Zea Mays, *Linn.*
Tragus racemosus, *Desf.*
Imperata arundinacea, *Cyr.*
Saccharum ciliare, *N. J. Anderss.*; β. Griffithii, *Hackel.*
Alopecurus pratensis, *Linn.*
Aristida cærulescens, *Benth. & Hook. f.*
Stipa capillata, *Linn.*
? Stipa, near S. Roylei.
Oryzopsis cœrulescens, *Benth. & Hook. f.*
Polypogon littoralis, *Smith.*
— monspeliensis, *Desf.*

Avena sativa, *Linn.*
Cynodon Dactylon, *Pers.*
Eleusine (§ Dactyloctenium) scindicum, *Boiss.* (= D. ægyptiacum depauperatum ?).
— flagellifera, *Nees.*
Chloris villosa, *Pers.*
Calamagrostis lanceolata, *Roth.*
Agrostis alba, *Linn.*
Tristachya Stocksii, *Boiss.*
Catapodium filiforme, *Nees*, var.
Boissiera bromoides, *Hochst.*
Phragmites communis, *Trin.*
Eragrostis pilosa, *Beauv.*
— glandulosa, *Trin.* ?
— poæoides, *Beauv.*
— cynosuroides, *Beauv.*
Melica Jacquemontii, *Decne.*
Æluropus littoralis, *Parl.*, var.
Schismus marginatus, *Beauv.*
Poa distans, *Linn.*
— subtilis, *Kar. et Kir.*; (syn. Nephelochloa soongarica, *Schrenk*).
— bulbosa, *Linn.*
Koeleria cristata, *Pers.*, var.
— phleoides, *Pers.*
Festuca elatior, *Linn.*
— uniglumis, *Soland.*
Bromus arvensis, *Linn.*
— crinitus, *Boiss. & Buhse.*
— Danthoniæ, *Trin.*
— squarrosus, *Linn.*
— tectorum, *Linn.*
Lolium persicum, *Boiss. et Hoh.*
Agropyrum cristatum, *Boiss.*
— (Heteranthelium) piliferum, *Hochst.*
— caninum, *Beauv.*, var. ? (A. semicristatum, *Nees.*)
— orientale, *Roem. & Schult.*
— junceum, *Beauv.*, var. ?
Hordeum murinum, *Linn.*
— pratense, *Linn.*
Ægilops squarrosa, *Linn.*
Pollinia eriopoda, *Hance*; (syn. Spodiopogon angustifolium, *Nees*).
Oryza sativa, *Linn.*

FILICES.

Cheilanthes Szovitzii, *Fisch. & Mey.*
Asplenium Ruta-muraria, *Linn.*
— viride, *Hudson.*
Adiantum Capillus-Veneris, *Linn.*
Cystopteris fragilis, *Bernh.*
Pteris longifolia, *Linn.* ?

EQUISETACEÆ.

Equisetum ramosissimum, *Desf.*

CHARACEÆ.

Chara sp. indeterminata.
Nitella sp. indeterminata.

MUSCI.

Hypnum (Stereodon) cupressiforme, *Linn.*

DESCRIPTIONS OF THE NEW SPECIES.
(By Mr. Hemsley.)

Leptaleum hamatum, *Hemsley & Lace*, n. sp. (Plate XXXVIII.)

Herba annua, gracilis, pumila, 1–5 poll. alta, simplex vel plus minus ramosa, undique glabra vel obscurissime parcissimeque puberula vel pulverulenta. *Folia* carnosa, linearia (semper indivisa), obtusa, 9–24 lineas longa. *Flores* pauci, breviter pedicellati, rosei vel lilacini, fere semipollicares; sepala linearia, vix acuta, erecta, basi subæqualia; petala anguste obovato-spathulata, sepalis subduplo longiora; stamina 4 longiora per paria ad apices filamentorum confluentia. *Siliqua* angusta, teres, circiter bipollicaris, apice hamata, tarde dehiscens, stylo subnullo; semina uniseriata, longissime funiculata, oblonga, echinulata, cotyledonibus incumbentibus.

Shelabagk, Khojak Pass, at 6000 feet.

Although the shape of the pod is very different, and the seeds are uniseriate, the present plant is so like *Leptaleum filifolium* in other characters that we have no hesitation in placing it in the same genus.

Dr. Stapf suggests that *Leptaleum* can hardly be maintained as generically distinct from *Malcolmia*.

DESCRIPTION OF PLATE XXXVIII.

A plant of *Leptaleum hamatum*, Hemsley & Lace, natural size.
Fig. 1, a flower; 2, the genitalia; 3, a seed; 4, embryo. All enlarged.

Gypsophila (§ **Eugypsophila-Capitatæ**) **lignosa**, *Hemsley & Lace*, n. sp.

Frutex nanus, dense ramosus, ramulis graciliusculis ultimis elongatis floriferis minutissime puberulis cortice albido vel viridi. *Folia* pauca, opposita, internodiis sæpius brevibus, vel in ramulis brevibus lateralibus conferta, teretia, crassiuscula, acuta vel fere spiniformia, maxima vix pollicaria, sed sæpius semipollicaria, hispidula, glauca. *Flores* parvi, absque staminibus, vix 3 lineas longi, sessiles, densissime capitati, capitulis solitariis terminalibus longe pedunculatis 4–6 lineas diametro; bracteæ ovato-oblongæ, obtusæ vel subacutæ, floribus dimidio breviores, parce puberulæ, medio incrassatæ, marginibus membranaceæ, interiores minores et omnino membranaceæ; calyx herbaceus, obscurissime puberulus, subcylindricus, sursum leviter expansus, breviter 5-fidus vel 5-dentatus, dentibus latis subobtusis; petala anguste spathulata, apice rotundata, calycem paullo superantia; stamina ut videtur longiuscule exserta; ovarium circiter 8-ovulatum, stylis 2 inclusis. *Capsula* deest.

Ziarat at 9000 feet.

Allied to *G. capitata*, Bieb., and *G. sphærocephala*, Fenzl; differing from both in having terete leaves, and solitary heads of flowers; the flowers much smaller and looser than those of the former species; and the whole plant much more shrubby than the latter. The flowers also differ considerably in detail.

Colutea armata, *Hemsley & Lace*, n. sp. (Plate XXXIX.)

Frutex dense ramosus, petiolis nonnullis induratis spiniformibus armatus, ramulis hornotinis parce albido-strigillosis, ramis annotinis et vetustioribus cortice deciduo pannoso vestitis. *Folia* imparipinnata, sæpissime 5-foliolata, breviter petiolata, undique albo-strigillosa, maxima vix pollicaria, stipulis parvis

squamiformibus ; foliola crassa, breviter petiolulata, ovali-oblonga vel interdum obovato-oblonga, apice rotundata vel obscure emarginata, 2–3 lineas longa. *Flores* parvi, circiter semipollicares, pedunculis axillaribus solitariis brevissimis 1–2-floris; calyx latus, albo-strigillosus, dentibus distantibus parum inæqualibus subulatis; vexillum subsessile, latius quam longum; alæ ovali-oblongæ, brevissime unguiculatæ, late auriculatæ, quam carina fere dimidio breviores; carina longiuscule latiusculeque unguiculata, subite cucullata, vix incurva; stamen vexillare liberum, filamento deorsum incrassato; ovarium breviter stipitatum, minute puberulum, sæpe 9-ovulatum, stylo vix barbato incurvo. *Legumen* breviter stipitatum, inflatum, membranaceum, tenuissimum, oblique ovoideum, circiter pollicare, indehiscens? ; semina matura non visa.

Wainu Pil Hill at 7000 feet.

DESCRIPTION OF PLATE XXXIX.

A branch of *Colutea armata*, Hemsley & Lace, natural size.
Fig. 1, part of calyx and ovary; 2, standard; 3, a wing; 4, keel; 5, stamens: all enlarged; 6, a seed, natural size.

Cratægus (§ **Pleiostylæ**) **Wattiana**, *Hemsley & Lace*, n. sp. (Plate XL.)

Arbor parva, inermis, ramulis ultimis floriferis crassiusculis brunneis nitidis. *Folia* conferta, graciliter petiolata, omnino glabra, papyracea, demum subcoriacea, ambitu ovato-oblonga, elliptica, vel interdum fere rotundata, absque petiolo usque ad 3 poll. longa, breviter pinnatifida, simul longiuscule apiculato-dentata, basi sæpius truncata vel rotundata, rarius cuneata, venis paucis primariis exceptis inconspicuis; petiolus fere filiformis, 6–10 lineas longus; stipulæ cito deciduæ, obliquæ, 4–6 lineas longæ, glanduloso-dentatæ. *Flores* albi, circiter 6 lineas diametro, laxiuscule corymbosi, corymbis terminalibus duplicatis brevissime pedunculatis, bracteis albidis glanduloso-dentatis cito deciduis, pedicellis gracilibus pauciglandulosis; calycis glabri lobi petaloidei, lanceolato-oblongi, obtusi, arcte recurvi; petala fere orbicularia, leviter undulata; ovarium 5-loculare, stylis distinctis. *Drupa* flava, ovoidea vel fere sphæroidea, 4–5 lineas longa, siccitate 5-sulcata.

Urak Gorge at 7300 feet.

Nearest to the Chinese *C. pinnatifida*, Bunge, which has much

more deeply divided leaves on longer petioles, larger flowers, and a red fruit.

DESCRIPTION OF PLATE XL.

Flower and fruit-bearing branchlets of *Cratægus Wattiana*, Hemsley & Lace, natural size.

Fig. 1, a flower from which the petals and stamens have been removed; 2, a petal; 3, vertical section of the pistil. All enlarged.

Rubia infundibularis, *Hemsley & Lace*, n. sp.

R. albicauli, β. stenophyllæ, Boiss., simillima, differt caulibus distincte tetragonis, pedunculis paucifloris, corolla distincte angusteque infundibulari, staminibus stylisque longe exsertis.—*Syn.* Rubia albicaulis, var. stenophylla, *Hook. f. Fl. Brit. Ind.* iii. p. 204, *non Boiss.*; Rubia Kotschyi, *Aitch. in Journ. Linn. Soc., Bot.* xviii. p. 65.

North-West India: Murree (*Fleming*); Jhelum Valley, Wazaristan (*Stewart*); Baluchistan: Ziarat (*J. H. Lace*); Afghanistan: Kuram Valley (*Aitchison*).

This so strongly resembles *Rubia albicaulis*, Boiss., that one would suspect the differences in the flowers to be sexual did not both produce fruit.

Tanacetum macropodum, *Hemsley & Lace*, n. sp.

Fruticulus ex affinitate *T. dumosi* et *T. Fisheræ*, basi lignosus, pauci-ramosus, ramulis floriferis erectis gracilibus nudis vel infra medium paucifoliatis monocephalis usque ad 15 poll. longis glabris vel cito glabrescentibus. *Folia* pauca, rigida, petiolata, alte pinnatifida, subtus parce appresso-puberula, segmentis paucis (utroque sæpius 2 vel 3) distantibus angustissimis planis apice aculeatis, interdum furcatis vel trilobatis. *Capitula* multiflora, circiter 5–6 poll. diametro, erecta; involucri bracteæ 3–4-seriatæ, exteriores breviores, oblongæ, latissime scariosæ, apice rotundatæ, plus minusve laceratæ, dorso incrassatæ, fuscæ. *Flores* flavi, involucrum parum excedentes; corolla cylindrica, florum exteriorum latiuscula. *Achænia* (matura non visa) glabra, interiores calva, nonnulla exteriores pappo dimidiato instructa, pappo squamiformi scarioso truncato.

Zandra at 7000 feet.

This differs from *T. Fisheræ*, Aitch. & Hemsl., in having larger leaves with longer flat segments, in the very long peduncles or flowering-branches, and the very broadly scariose involucral bracts.

Saussurea rupestris, *Hemsley & Lace*, n. sp.

Species distincta ex affinitate *S. salicifoliæ*, undique glabra vel cito glabrescens, caulibus erectis gracilibus pauci-ramosis viridibus $1\frac{1}{2}$–2-pedalibus, parce foliatis vel sursum fere nudis. *Folia* radicalia non visa, caulina pauca, distantia, subsessilia, crassa, rigidiuscula, spatulata, anguste lanceolata vel superiora fere linearia, maxima sesquipollicaria, acute apiculata. *Capitula* pauca, laxe corymbosa, circiter 8-flora, 9–10 lineas longa, ut videtur rosea; involucri bracteæ 5–6-seriatæ, anguste oblongæ, acutissimæ, rigidiusculæ, interiores longiores margine scariosæ, exteriores minimæ. *Corolla* glabra, pappum triente superans, lobis linearibus; stamina exserta, filamentis filiformibus glabris, antheris apiculatis caudicibus parvis puberulis. *Achænia* matura non visa, immatura leviter glandulosa; pappus uniseriatus, setis 15–20 longe plumosis.

Kawas Tangi at 7000 feet, on limestone rocks in sheltered situations.

Primula Lacei, *Hemsley & Watt*, n. sp. (Plate XLI.)

Species habitu foliisque *P. Aucheri* similis, sed floribus breviter pedicellatis in apicibus caulis densissime foliiferi fasciculatis, nec verticillatis involucratis. *Caules* ramosi, sublignosi, elongati, infra apices nunc vestigiis foliorum vetustorum vestiti, nunc squamis paucis exceptis nudi, brunnei, parcissime villosuli vel glabri. *Folia* in apicibus caulorum vel ramorum densissime conferta, obovato-spatulata, 6–24 lineas longa, apice rotundata, deorsum attenuata, nec distincte petiolata, tenuiuscula, mollia, plus minusve albo- vel aureo-lanata, dentata, interdum grosse irregulariterque dentata. *Flores* lutei, brevissime pedicellati, bracteis linearibus suffulti; calyx pulverulentus vel glaber, alte 5-fidus, segmentis linearibus acutis quam corolla $\frac{2}{3}$ brevioribus; corolla hypocraterimorpha, vix pollicaris, tubo angusto sursum leviter expanso, lobis rotundatis integris patentibus; genitalia inclusa. *Capsula* globosa.

Torkhan, 4000 to 4500 feet.

This has the suffruticose growth of *P. Aucheri* and *P. verticillata*, but is otherwise very distinct.

DESCRIPTION OF PLATE XLI.

Portion of a plant of *Primula Lacei*, Hemsley & Watt, natural size.

Fig. 1, a leaf; 2, a flower from which the corolla has been removed; 3, corolla laid open, showing the insertion of the stamens; 4, ripe capsule, from which a part of the calyx has been removed.

Cynanchum petrense, *Hemsley & Lace*, n. sp.

Species humilis habitu foliis cymis pedunculisque *C. Jacquemontii* simillima sed plus minusve canescens, coronæ lobi columnam superantes, crassi, obtusissimi, lateris retroflexis, intus obtuse ligulati. *Folliculi* ignoti.—Cynanchum humile, *Aitch. in Journ. Linn. Soc., Bot.* xviii. p. 79, *non Falconer.*

Baluchistan: not uncommon on rocks in Upper Baluchistan (*Stocks*, 920); in stony places, Shamack, Kurrum Valley (*Aitchison*, 44), Pil Hill (*J. H. Lace*, 3825).

This and *C. Jacquemontii*, Decne., are so alike, except in the corona, that there is nothing appreciable to put in a description. Perhaps the follicles may afford some more tangible character. In the meantime we have followed Sir Joseph Hooker in separating them.

Arnebia (§ **Macrotomia**) **inconspicua**, *Hemsley & Lace*, n. sp.

Herba perennis undique longe patenteque setoso-aculeata, simul strigillosa, subscaposa (depauperata ?), 4–6 poll. alta. *Folia* radicalia rigida, lineari-oblonga, 1–2 poll. longa, acuta, costa subtus elevata marginibusque præcipue setosa; caulina pauca similia, angustiora. *Flores* cærulei, dense congesti, 7–8 lineas longi; calycis segmenta angustissima, longissime setosa, corollam fere æquantia; corolla intus nuda, extus, præcipue supra medium, dense setulosa (vel lobis hirsutis simul vere setosis), angusta, tubo sursum parum dilatato dein subite globoso-inflato, lobis parvis oblongis vix patentibus; stamina inclusa, fauce tubi affixa; ovarium glabrum, stylo brevi bifido, stigmatibus obscure bilobatis. *Nuculæ* maturæ non visæ sed juniores læves et glabræ.

Zarghun at 9500 feet. Also from Zahru (*Stocks*, 866, in part), and from Cabul, collected by General Collett.

Possibly a depauperate state of *Macrotomia cyanochroa*, Boiss., but the small, very bristly flowers, and apparently naked nutlets, point to specific difference. There is also the one plant collected by Stocks, and confused with another species, which is exactly like ours, and all that could be found in the Kew Herbarium, except the two small pieces collected by General Collett near Cabul.

Scutellaria petiolata, *Hemsley & Lace*, n. sp.

Suffrutex minute puberulus vel hispidulus, caule brevi incrassato lignoso ramulos floriferos multos gracillimos 6–12-pollicares

M. Smith del. C. Fitch lith. J. N. Fitch imp.

LEPTALEUM HAMATUM, *Hemsl. et Lace*

M. Smith del. C. Fitch lith. J. N. Fitch imp.

COLUTEA ARMATA, *Hemsl. et Lace.*

LINN. SOC. JOURN. BOT. VOL. XXVIII. PL. 40.

M. Smith del. C. Fitch lith.

J. N. Fitch imp.

CRATÆGUS WATTIANA, *Hemsl. et Lace*.

M. Smith del. C. Fitch lith   J. N. Fitch imp

PRIMULA LACEI, *Hemsl. et Watt.*

London: Stanford's Geog! Estab!

annuos emittens. *Folia* longe petiolata, crassiuscula, herbacea, cordato-ovata, absque petiolo $\frac{1}{2}$–$1\frac{1}{2}$ poll. longa, vix acuta, basi cordata vel rotundata, integra vel sæpe grosse paucidentata (utrinque dentibus 3–4), vix hispidula, venis primariis lateralibus utrinque 2–3 sat conspicuis; petiolus gracillimus, laminam sæpe æquans vel interdum excedens. *Flores* subsecundi, pollicares, in racemos breves densos dispositi, brevissime pedicellati, bracteis foliaceis parvis ovatis petiolatis muniti; calyx puberulus; corolla puberula, arcuata, tubo gracili; stamina inclusa. *Nuculæ* ignotæ.

Ziarat.

Similar to *S. grossa*, Wall., but having a more woody caudex, slenderer flowering-stems, and slenderly petiolate few-toothed or entire leaves.

Report on a Botanical Visit to Lord Auckland, Campbell, Antipodes, and other Antarctic Islands, in a Letter from THOMAS KIRK, F.L.S., Chief Conservator of State Forests, New Zealand, to Sir JOSEPH D. HOOKER, K.C.S.I., F.R.S., F.L.S. (Communicated by the latter.)

[Read 15th January, 1891.]

Wellington, New Zealand,
Sept. 6th, 1890.

MY DEAR HOOKER,

I have been to the Auckland Islands, and give a few short notes on my trip, which I am vain enough to think will interest you. Unhappily the trip was a very hasty one, only a few hours ashore at any one place; so that I only got fairly on the hills at Carnley Harbour; yet I succeeded in picking *all* the recorded flowering-plants and ferns, except some twelve or fourteen to be mentioned presently. We landed at the Snares, Port Ross, Ewing, and Rose Islands, and on the site of Enderby's Settlement, Carnley Harbour, Campbell Island, and Antipodes Island. I made some small additions, including a few novelties. The following are the plants found by you, but not seen by me:—

Ranunculus acaulis.
R. subscaposus.
Colobanthus subulatus.
Myosotis antarctica.
Urtica aucklandica.
Gaimardia ciliata.
Deschampsia cæspitosa, with 1-flowered spikelets.
"Catabrosa" antarctica.
Hymenophyllum demissum.
H. flabellatum.
H. rarum.
Todea superba.
Polypodium Grammitidis.
Lycopodium scariosum.
Lomaria lanceolata.

Amongst the novelties are a charming "*Triodia*," from the hills above Carnley Harbour; a *Ranunculus* from the same place (not *R. aucklandicus*); a *Stellaria* allied to *S. decipiens*; another "*Triodia*" from Antipodes Island; a handsome *Aralia*, similar to my *A. Lyallii*, but with petioles like those of garden rhubarb; a fine *Celmisia* of the *vernicosa* type, but with broad leaves; a small *Pleurophyllum*; a grand herbaceous *Senecio*, the heads of which reminded me of *S. candicans*; a curious *Gentiana*, *Poa* sp., and some others, besides a few additions, as *Carpha*, *Phormium*, *Samolus*, &c. Unfortunately I was badly sea-sick the whole time; so that my specimens did not fare so well as could have been wished; but this did not interfere with my getting about.

The Snares are covered with vegetation, although there is but little variety; but imagine the effect of two such grand plants as *Olearia Lyallii* and *Senecio Muelleri* in mass! Both attained the height of 25 feet; the latter, with a trunk 1 to 2 feet in diameter, is surely the largest member of the genus. Some of the leaves of the *Olearia* were 7 inches long; the flowers are like those of *S. Colensoi*, destitute of ligulate florets; and there is but little to distinguish the two except the large, more ovate, less acuminate leaves, and more open habit of *O. Lyallii*: one grand specimen on Ewing Island was 30 feet high, and another on Point Ross was nearly as large. What appeared to be the same plant occurred on the south head of Carnley Harbour, where it was a low shrub; but I was unable to land.

Antipodes Island is simply the crater of an extinct volcano; its largest shrub was *Coprosma cuneata* (identified in the absence of flowers); the only others observed were *C. ciliata* and *C. repens*. Fifty-four plants were collected. On the Snares only twenty-nine, several of which were introduced. Cattle, sheep, and goats have been introduced in all these islands: rabbits have been turned out on Macquarie Island and at Port Ross. The cattle greedily devour *Stilbocarpa* on Antipodes Island, eating even the rhizomes; so that some of our choicest things will soon be thinned.

A remarkable gentian was abundant on Antipodes Island, forming dense masses, 6 to 12 inches high and 1 to 2 feet in diameter; the subprocumbent stems gave off numerous erect, strict branches. Some specimens exhibited yellow stems and leaves, with white flowers; others red stems and leaves with white flowers streaked with red; so that in both forms alike the

flowers were unnoticed until the plant was examined somewhat closely. I unite with this your *Gentiana concinna* from Campbell Island. All the specimens of *G. concinna* observed had self-coloured flowers, red, purple, and white, but none were streaked. *G. cerina* was plentiful on Shoe Island, Ross Island, &c., and on the hills up to 1200 feet at Carnley Harbour, the flowers being self-coloured white, red, or purple, or less frequently streaked; it is a lovely plant.

Chrysobactron Rossii was past flowering, so also *Pleurophyllum criniferum*; *P. Gilliesianum* was nearly past, *P. speciosum* at its maximum. I did not see Buchanan's *P. Hookeri*, which seems to be identical with *P. Hombronii*, Decne., judging from the description and plates in 'Voy. au Pôle Sud,' and Trans. N. Zeal. Inst. xvi. t. 37, and that again in all probability is *P. criniferum*; both, however, show globular flower-heads, while in *P. criniferum* they are discoid. *P. Gilliesianum* has globular heads; but the scapes are always naked, and the leaves differ widely from those represented by either drawing. I found the leaves of *P. criniferum* invariably petiolate, the petiole sometimes 8 to 12 inches long or more; you describe them as amplexicaul: it maintains the petiolate character under cultivation in Ch. Traill's garden at Stewart Island. There appear to be two well-marked forms of *P. speciosum*. The Auckland Island plant has whitish or pale ray-florets, and the leaves have no moniliform hairs; the Campbell Island form has violet-coloured ray-florets, and the leaves produce moniliform hairs profusely on the upper surface. These differences have been constant under cultivation during twelve years.

The *Dracophyllum scoparium* of Campbell Island is endemic, the plant referred by New Zealand botanists to that species being very different. The island plant has the habit of *Cupressus sempervirens*, and possesses good claims to specific distinction. Buchanan is in error in referring the Chatham Island plant to this form. There are two forms of *Dracophyllum longifolium* on the islands, one with terminal racemes, the other with lateral.

Hypolepis Millefolium is frequent; I think there can be little doubt as to its identity with *Polypodium rugulosum*, which attains to a large size.

The island form of *Ranunculus pinguis* differs from any thing we have on the mainland in the large heads of fruit, pale colour, and lobulate teeth. The mainland plant, whether glabrous or hairy, is nearly always branched; branched specimens are

extremely rare in the islands. *R. aucklandicus* is not unfrequent on Campbell Island; but I failed to find *R. subscaposus.*

Your *Rumex cuneifolius*, var. *alsinæfolius*, is my *R. neglectus*; observed only in Port Ross. *Colobanthus muscoides* is found sparingly on the Snares, and plentifully on Antipodes Island, so that its northern range is considerably extended. *Pozoa reniformis* occurred on the Auckland Islands as well as on the Campbell Islands. I found it many years ago in the Spenser Mountains, Nelson, and received specimens from the Ashburton ranges (both in New Zealand).

One or two patches of *Coprosma repens* with simple stems less than 1 inch high bore hermaphrodite flowers. *Celmisia verbascifolia* is a fine addition to the Campbell Islands flora: the flowers are the largest I have seen.

At Port Ross and other places I found two or three species of *Corysanthes.* About *C. macrantha* and *C. rivularis* I feel certain, although flowers were not seen; but another flowerless plant, which may have been referred by you to the *C. rotundifolia*, appeared to me the same as the one-flowered monophyllous orchid from Mount Anglein, in Stewart Island, which you thought would constitute a new genus, intermediate between *Burnettia* and *Caladenia.*

I have been much puzzled with your *Ligusticum intermedium* and *L. Lyallii*, of which, or rather of the former, good specimens from Port Preservation and Stewart Island have been sent to Kew; but I can find nothing that exactly agrees with *L. Lyallii.* On the Snares a few plants of a large form, 5 feet high, with stems 2 inches in diameter, were found in fruit; the leaves bipinnate, pinnæ pinnatifid, segments acute; fruit longer than the pedicels. The entire plant devoid of the milky juice so characteristic of *L. intermedium.*

I hope this will not prove wearisome: should it do so, please remember that more than forty years ago reviews of 'Flora Antarctica' laid fast hold of me, and kindled an intense desire to see *Chrysobactron Rossii*, *Pleurophyllum speciosum*, and *Celmisia vernicosa* in their native soil. After long waiting, the hasty pleasure has been realized, and I hope to enjoy it again before I die.

Believe me,

Yours truly,

T. Kirk.

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VOLS. XXVI., XXVIII., & XXIX. are in course of simultaneous issue to expedite the publication of papers, and the Parts already published are as follows:—

Vol. XXVI., Nos. 173–175, and 176.

(Nos. 177–180 are reserved for the continuation of Messrs. Forbes and Hemsley's 'Index Floræ Sinensis.')

Vol. XXVII., Nos. 181–188. (Complete.)

Vol. XXVIII., Nos. 189–193, and 194, the present Part.

(Nos. 195–196 will complete the volume.)

Vol. XXIX. No. 197 will be issued shortly.

Attention to this announcement is specially requested, to prevent application to the Librarian for unpublished Parts.

The Library will be closed during the entire month of August, for the usual cleaning and revision of books.

The announcement of the dates of the Meetings of the ensuing Session will be sent to the Fellows in October.

OCTOBER 31. *Price 5s.*

THE JOURNAL

OF

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VOL. XXVIII. **BOTANY.** No. 195.

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NOTE.—The Charter and Bye-Laws of the Society, as amended to the 19th March, 1891, may be had on application.

The Genus *Bromheadia*.

By H. N. Ridley, M.A., F.L.S.

[Read 4th December, 1890.]

(Plate XLII.)

The small genus *Bromheadia* is one whose relationship seems still rather obscure. It is generally relegated to the neighbourhood of *Cymbidium* and *Polystachya*, but it stands alone without any definite affinities with these or any other genus. Although one species has long been known in collections, and even cultivated in England, many points about it are still obscure. Thus in Bentham and Hooker's 'Genera Plantarum' there is a query as to its being terrestrial, and the fruit of no species has been described. I have met with four species in Singapore, have cultivated them for some time in the Botanic Gardens, and propose herewith to describe them, adding notes on their habitats, &c.

The commonest and best known species is *B. palustris*, Lindl., most inaptly so named, as it prefers hot sunny places as its habitat. It is the finest and most ornamental plant in the genus, a stiff plant from one to six feet in height, with spreading distichous leaves rather distant below and gradually passing into sheaths at the top of the otherwise bare stem, where it has also a tendency to branch. The raceme is flexuous, usually quite short, with cup-like bracts. The flowers open singly, more rarely two are open at once on the flower-spike; they are large and conspicuous and very sweetly scented, opening in the early morning and closing very soon. This habit is very characteristic of the genus. They are visited by the common carpenter bee (*Xylocopa* sp.) and are often fertilized. The sepals are acutely lanceolate and keeled, pure white or tinged with pink. The petals are broader, shorter, and pure white. The lip is three-lobed, the lateral lobes erect, oblong, rounded, white, veined with violet-pink, the middle lobe longer.

The fruit of all the species is very similar—a straight, almost cylindrical capsule, sessile, about an inch and a half long, erect, crowned with the remains of the perianth. The ribs are unequal, the sterile ones narrower than the fertile ones, raised, with grooves between each, and rounded backs. The fruit of *B aporoides* I have not seen.

Bromheadia palustris is very common in Singapore, growing usually among the ferns and long grass, in open districts, rarely in shady or damp places. It is distributed over the whole of the peninsula, from Siam southwards, and in the Malay Islands as far east as the Philippines.

B. sylvestris, n. sp., is a closely allied plant to this, and, like it, is terrestrial. In the dry state it is not at all easy to distinguish it. It is usually a larger plant, weaker, with thinner, less coriaceous leaves, and slender stems, growing in tufts and very tenacious, with numerous roots. It frequents the more open damp jungles, where, however, it seems rarely to flower. It is generally easy to distinguish living plants even when out of flower, and though I have seen a large number of plants, I have but seldom seen the flowers. The flowers are of a beautiful apricot-yellow, as large as, or larger than, those of *B. palustris*, and were it more floriferous would be well worthy of cultivation. The lip is narrow, with the lateral lobes erect, beautifully veined with dark crimson, the intermediate line bright yellow. The middle lobe is ovate-acute, the edges white, the central bar of the lip ending upon it in the form of a bright orange raised lump. The sepals and petals are somewhat narrower than in the preceding species, bright apricot-yellow. The column yellow, with pink stains at the base.

The two epiphytic species are *B. alticola*, n. sp., and *B. aporoides*, Reichb. f. The first of these is not rare in Singapore, but very difficult to procure. It frequents the loftiest and most inaccessible trees, usually *Dipterocarpeæ*, growing on the highest branches or on the trunk, where it forms masses of four or five feet in diameter. The stems are very numerous, about two feet high, flattened and leafy. The leaves are narrower and longer than in *B. palustris*, stiff, spreading, and unequally bilobed at the apex; they are articulated with the sheath, so that in drying they usually fall off. The raceme is not preceded by a long leafless portion, but rises directly from the leafy part of the stem; it is often branched, or rather short lateral racemes arise from the base. The rhachis is flattened and flexuous, with very large cup-shaped bracts. The flowers are smaller than those of *B. palustris*, sweetly scented, and quite as fugacious; they open singly in the early morning and perish when the sun is well up. In this plant, as in the others, the raceme itself lasts a very long time and at intervals produces one flower, so that the lower bracts are brown and dry before the raceme has

finished elongating itself and producing flowers. The plants all produce their flowers at the same time, so that when one plant is in flower one may be certain that the others are so also, and, conversely, when one plant is not flowering, it is almost useless to examine any other plants, even in different parts of the garden. This phenomenon is not confined to Bromheadias; it is very well known in the case of *Dendrobium crumenatum*, Lindl., which flowers here with striking regularity. At certain intervals, about once in six weeks, every plant in the district may be observed covered with buds; the next day every tree is white with the blossoms, which fade towards evening; and on the following day it is impossible to find any but withered flowers. Some Ericas and other Orchids do the like. *Bromheadia palustris* is comparatively seldom out of flower; *B. alticola* is a rare flowerer. The flowers of the latter species much resemble those of *B. palustris*; but, besides being small, have less purple and yellow on the lip. The capsule is much like that of *B. palustris*, but a little longer, the ribs elevated, and the grooves between them more obscure.

B. aporoides, Reichb. f., I have only once met with. It was growing upon a lofty Serayah tree (*Hopea* sp.) which had been felled, in company with the last-named species. I have not seen the type specimen of the plant described by Reichenbach in 'Otia Hamburgensia'; but his description applies to our plant very well, and I have no doubt that it is the same thing. It forms a large tufted mat about a foot across. The stems are erect, short, flattened, and covered with distichous, stiff, equitant, recurved leaves quite pungent at the apices. The flowers are smaller than those of the other species, greenish white, with purplish and yellow stains on the lip; they arise singly from a terminal tuft of brown sheaths, almost sessile in the terminal leaves, and appear more rarely than in the other species. The whole plant is very dissimilar even to *B. alticola*, and would easily be taken for an *Oxystophyllum*, even when in flower.

Now here we have a genus which includes plants closely allied but differing much in habit of life, so that it is interesting to see what differences in structure are correlated with different habitats. One of the first noteworthy points of the difference between the epiphytes and terrestrial species is that in the former the laminæ of the leaves are articulated with the sheath so as to drop off on withering, while in the terrestrial they wither on the stem. A

parallel case occurs in *Liparis*, where the terrestrials usually have softer leaves withering on the stems, the epiphytes having articulated ones. Pfitzer ('Morphologische Studien') has separated the genus into two mainly on this ground. In the epiphytic species the rhizome is more branched and the masses attain a larger size. This is certainly due to the smaller amount of competition upon the lofty trees where the epiphytes grow. Another noticeable point is in the shortening of the stem. The terrestrial species attain a height of six feet in damp localities, and there are oftener branches in the inflorescence, so that it partakes more of the nature of a panicle. The shortening is most conspicuous in *Bromheadia aporoides*, where the inflorescence appears as a tuft of brown bracts, almost capitulous, but even then showing signs of branching at the base. The elongate stems of *B. palustris* and *B. sylvestris* are doubtless brought about by competition with the surrounding herbage, besides the dampness of the lower stratum of air which increases the vegetative activity. There is no competition upon the lofty trees where the epiphytes grow, and in all probability the air is drier. The strong wind which often must buffet the epiphytes, too, would probably cause much damage to long straggling plants like the terrestrial ones.

B. alticola has the leaves distinctly bilobed, as is very common in other epiphytes. This has almost entirely disappeared in *B. palustris*.

The leaves of *B. aporoides* are laterally flattened, stiff, recurved, and pungent, very much like those of some *Dendrobium*, but less succulent. This plant was growing on the tree with the stems at right angles to the trunk, so that the edges of the leaves would have been turned up to the light had the plant had them flattened in the normal manner, which is perhaps the reason for their being laterally flattened.

The two epiphytes and *B. palustris* are real sun-loving plants. They grow exposed to the full blaze of the sun, and the flowers of all are somewhat similarly coloured; the prevailing colour is white, somewhat greenish in *B. aporoides*. The two others are visited by a species of *Xylocopa* which is very abundant in Singapore, and nests both in stumps and old timber on the ground and in the dead branches of taller trees, often very high up. The bee is certainly not particular as to the colouring of the flowers it visits; but the white flowers of these two species are very showy and conspicuous. White flowers are fairly abundant in

Singapore, and are very characteristic of the taller trees, where they are exposed to full light. Orange-yellow flowers, like those of *Bromheadia sylvestris*, on the other hand, are rare; indeed, this colour occurs almost solely in *Calanthe curculigoides*, some Globbas, and a species of *Alpinia* (*A. Rafflesiana*), all of which grow in similar localities to the *Bromheadia*. The same peculiar orange colour appears in most of the native Gardenias, the flowers of which open white, and so speedily turn orange-yellow that it is rare to see a white flower on the tree.

I would merely suggest that the differences between these species are rather vegetative than reproductive, and that as they seem to bear no relation to the fertilizer, which is the same apparently for all, they are due to change of habits; and from the stiffness of the leaves and stems and other peculiarities of *B. palustris*, I am inclined to suspect it is derived from an epiphytic ancestor, and its relations are to be sought in a somewhat different direction to that in which they are supposed to lie.

Bromheadia.

Herbæ rigidæ, terrestres vel epiphyticæ, rhizomate ramoso, caules ebulbosi compressi; folia disticha rigida sæpius lanceolata obtusa, apice bilobo, raro ensiformia recurva pungentia. Inflorescentia racemosa, racemis 1-, 2-, 3- vel multifloris flexuosis gradatim elongatis, raro congestis brevibus. Bracteæ persistentes cymbiformes. Flores sæpius speciosi albi vel aurantiaci singulatim intervallis longis expansi. Sepala lanceolata acuta carinata. Petala paullo breviora atque latiora. Labellum trilobum; lobi laterales longiusculi erecti, medius longior atque latior plus minus obovatus; calcare nullo. Columna curva elongata, dorso convexo, ventre excavato, a labello libera, clinandrium profundum margine antheram superante. Anthera convexa, margine antico retuso. Pollinia 2, cerea, semiovata, disco late ovato emarginato. Rostellum profunde et late emarginatum. Stigma profundum grande. Capsula sessilis erecta longa, cylindrica, subteres, perianthio marcescente coronata, segmentis inæqualibus, fertilibus quam steriles duplo latioribus.

Species adhuc notæ 4. Malayanæ, a Siamo et Burma ad Singapuram et insulas Malayanas et Philippinas.

§ 1. *Terrestres.* Caulibus elongatis, superne longe nudis.

Flores albi	1. *B. palustris*, Lindl.
Flores aurantiaci	2. *B. sylvestris*, n. sp.

§ 2. *Epiphyticæ.* Caulibus brevioribus undique foliaceis.

Folia lanceolata plana, apicibus bilobis	3. *B. alticola*, n. sp.
Folia equitantia recurvata, apicibus acutis	4. *B. aporoides*, Reichb. f.

Terrestres.

1. Bromheadia palustris, *Lindl. Bot. Reg.* xxvii. 1841, *Misc.* 184; xxx. 1844, 18; *Hook. Bot. Mag.* t. 4001; *Wight, Icones,* t. 1740.—B. Finlaysoniana, *Reichb. f. in Walp. Ann.* vi. 630, 882; *Miquel, Fl. Jav.* i. 708.—Grammatophyllum? Finlaysonianum, *Lindl. Orch. Pl.* p. 173.

Planta terrestris, caulibus pluribus erectis 1–6-pedalibus rigidis lævibus complanatis, vaginis foliorum vix omnino tectis, superne vaginis dissitis exceptis, nudis. Folia disticha patentia subcoriacea marginata, obscure viridia, lanceolata obtusa, apice minute bilobo, mucronulata, superne canaliculata, subtus carinata, striata, rugosula, 5 uncias longa, 1 unciam lata, vaginis compressis costatis $1\frac{1}{2}$ uncias longis, ore integro; vaginis supremis non laminiferis apicibus ovatis longius dissitis, quaquaversis. Racemi flexuosi gradatim elongati, rhachide compressa, ad 3 uncias longi. Bracteæ cucullatæ $\frac{1}{8}$ unciales, acutæ. Flores singuli, sessiles, speciosi, odorati fugaces. Sepala lanceolata acuta carinata alba vel roseotincta, $1\frac{1}{2}$ uncias longa, $\frac{1}{4}$ unciam lata. Petala breviora, latiora et obtusiora, $1\frac{1}{4}$ uncias longa, $\frac{3}{8}$ unciam lata, alba. Labellum trilobum oblongum, $1\frac{1}{4}$ unciam longum; lobi laterales lanceolati subacuti longi angusti albi, violaceo-venosi præsertim ad apices; inter eos, linea elevata, apice rotundato pubescente, flavescenti-roseo punctato, lobus medius obovatus oblongus, mucronatus, $\frac{1}{2}$ unciam longus, $\frac{3}{8}$ latus, in medio pulchre flavus farinosus, marginibus albis tenuioribus, ad basin violaceo ornatis. Columna $\frac{3}{4}$ unciam longa, dorso gibboso, curva, ventre excavato, albo, basi violaceo-punctata. Margo clinandrii erectus, altus, superne emarginatus. Anthera subglobosa, apice obtuso, margine antico emarginato. Pollinia subtriangularia, flava, in disco profunde emarginato sessilia. Rostellum profunde emarginatum, lobis rotundatis. Stigma hemisphæricum, magnum. Capsula $2\frac{1}{2}$ uncias longa, sessile, $\frac{1}{4}$ unciam crassa, subteres, erecta.

Distribution. Cochinchina. Saigon! Malay peninsula, Pahang, near Pekan! Malacca, *Cuming* no. 2054! Sungei Udang! Mt. Ophir! Sungei Ujong! Selangor at Kwala Lumpor! Singapore, very common over the whole island. Borneo, Mt. Pennugus, *Teysmann*, 10981! Brang (*Dr. Haviland*)! Sintang (*Teysmann*, 8446!). Sumatra, fide *Miquel*. Java, Sungei Liat, *Teysmann*! Banka, *Teysmann*! Blitoeng Tandj, Nandan, *Teysmann* 11092!

The plant varies very little. There is a very tall form with stout stems as thick as the little finger, more terete than usual, which occurs in more wooded spots; the leaves of this are usually more elliptic than the common form, and it has also a little black pubescence on the rhachis and ovary.

I have once met with a peloric flower in which the lip was narrow linear lanceolate-acuminate, with no lateral lobes, and the raised median ridge wanting, the edge of the lip being suffused purple.

2. Bromheadia sylvestris, n. sp.

Caules erecti, 1–6-pedales, graciles, debiles, complanati, folia dissita tenuiora quam in præcedente lanceolata, apicibus inæqualiter bilobis, obscure viridia, carinata, circiter 5 uncias longa, $\frac{3}{4}$ unciam lata, terminalia et basalia ut in *palustri* sine laminis. Racemi 1–2 ad apicem caulis flexuosi iis *B. palustris* subsimiles, bracteis distichis cymbiformibus. Flores quam in *B. palustri* sæpius minores, rarissime visi, aurantiaci, unciam longi. Sepala lanceolata acuminata acuta carinata aurantiaca. Petala latiora æquilonga obtusiora eodem colore. Labellum quam petala brevius trilobum; lobi laterales erecti oblongi obtusi flavescentes, margine albo, venis kermesinis ornati, lobus medius ovatus acutus albus disco elevato flavo-aurantiaco, linea mediana inter lobos laterales elevata flava. Columna gracilis arcuata flava, basi kermesino-punctata. Anthera ovata. Clinandrii margo integer.

Singapore. Kranji, in sylvis densis et in locis umbrosis, hic et illic in Singapura sed rarius.

A very shy flowerer; but distinguished when not in flower by the weak stems, often producing leaf-buds instead of flowers, and the thin texture of the leaves, which are sometimes quite flaccid, instead of being stiff and hard as in *B. palustris*. Dried specimens are not at all easy to distinguish except by the unequal lobes of the apex of the leaves, of which, however, I have also seen traces in *B. palustris* when grown in dense shade. The colouring of the flower is unmistakable, and the narrower acute lip will also easily distinguish it.

Epiphyticæ.

3. Bromheadia alticola, n. sp. (Plate XLII.)

Cæspitosa, caules copiosi, e rhizomate ramoso exorti, complanati, 1–3-pedales, omnino foliis tecti. Folia patentia, laminæ lanceolatæ loratæ obtusæ, apicibus bilobis, rigidæ, læte virides, vaginis articulatæ, mox caducæ; vaginæ approximatæ complanatæ striatæ et transversim rugosæ, circiter $1\frac{1}{2}$ unciam vel minus latæ, ore obliquæ; laminæ 6 uncias longæ, $\frac{1}{2}$ unciam latæ. Racemi 2–3-unciales flexuosi, gradatim evoluti, folio supremo approximati, singuli, rarius 2 laterales additi. Bracteæ virides magnæ cymbiformes acutæ, $\frac{1}{4}$ unciam longæ. Flores singuli visi iis *B. palustris* minores, albi, odorati. Pedicellus cum ovario gracilis, 1 unciam longus. Sepalum posticum lanceolatum acutum, 1 unciam longum, $\frac{1}{4}$ unciam latum, lateralia lanceolata paullo obliqua acuta carinata. Petala lorata lanceolata subobtusa paullo breviora. Omnia alba. Labellum $\frac{3}{4}$ unciam longum angustum trilobum; lobi laterales angusti lanceolati acuti albi, apicibus violaceis, linea mediana elevata apice (ad basin lobi medii) abrupte rotundata obtusa, flava; lobus medius ovatus subacutus, medio elevato calloso flavo, marginibus et apice albis. Columna crassiuscula, curvula, basi haud angustata, dorso rotundato, ventre excavato albo, marginibus purpureis. Clinandrium parvum, margine dorsali ovato integro obtuso. Rostellum profunde bilobum, lobis obtusis incurvis. Anthera alba minute pustulosa, late ovata apice obtusa, margine antico profunde emarginato (anthera ferme biloba). Pollinia ovata triangularia flavescenti-alba, 2, dorso excavato; discus triangularis emarginatus tenuis, latus, brevis. Stigma profundum, ad marginem inferiorem 2 lobi parvi, quasi lobi rostelli. Stelidia brevia obscura. Capsula subteres, sessilis, erecta, triuncialis, una rima fissa.

Singapura in arboribus vastis alte crescens, cæspites magnas formans, ad Bukit Timah, Jurong, et Bukit Mandai, etiam in Selangor ad Kwala Lumpor. Sæpe faciliter visa, difficillime collecta.

4. Bromheadia aporoides, *Reichb. fil.*, *Otia Hamburg.* i. p. 44; *Parish in Mason's Burmah*, ii. p. 72.

Cæspitosa, caules perplurimi complanati, dense crescentes rigidi, 4-unciales. Folia rigida ensiformia equitantia recurvata, 4 uncias longa, $\frac{1}{4}$ unciam alta, obscure viridia, vaginis articulata, vaginis

J. de Alwis del.

J. N. Fitch lith.

BROMHEADIA ALTICOLA.

complanatis, ore obliqua brevibus. Racemi congesti brevissimi terminales vix $\frac{3}{4}$ unciam longi. Bracteæ mox siccæ brunneæ lanceolatæ. Flores albi vel virescentes fugaces singulatim expansi, quam in ulla specie minores. Sepala lanceolata æqualia acuta, haud carinata, polita, flavescentia, unciam longa. Petala paullo breviora pallidiora, vena centrali elevata. Labellum petalis æquans, tenue, $\frac{3}{4}$ unciam longum, oblongum panduratum (explanatum); lobi laterales obtusi, linea mediana elevata ante basim lobi medii desinit, apice aurantiaco; lobus medius tenuis, margine crispo, oblongus obtusus albescens, maculis duabus purpurascentibus ad basim, callo spathulato vix elevato flavo centrali. Columna gracilis, alba, vix curva, dorso rotundato, ventre plano vix excavato, superne subito dilatata; stelidiis latis rotundatis, margo clinandrii emarginatus. Pollinia parva flava subtriangularia; discus maximus quadratus profunde et late emarginatus. Rostellum profunde exsculptum, lobis magnis triangularibus. Stigma magnum, margine inferiore integro (*i. e.* sine lobis). Anthera minima lata conica nec pustulosa, apice rotundato, margine antico emarginato.

Burmah ad Tenasserim, *Parish*.

Singapura, in summo arbore vasto (*Hopea*, sp.) cum *Bromheadia alticola*. Ad Jurong crescens!

Planta Parishiana mihi nunquam visa, sed ex descriptione planta Singapuriana mihi videtur omnino eadem.

DESCRIPTION OF PLATE XLII.

Bromheadia alticola.

Fig. 1. Entire plant (much reduced).
2. Portion of a stem (natural size).
3. Lip (enlarged).
4. Column (enlarged).
5. Upper part of column (enlarged).
6. Capsule (nat. size).
7. Transverse section of capsule (enlarged).
8. Pollinia, back and front view.

On two New Genera of Orchids from the East Indies.

By H. N. Ridley, M.A., F.L.S.

[Read 2nd April, 1891.]

(Plates XLIII. & XLIV.)

Of the two curious plants which I herewith describe, one, *Leucolena*, was found growing in Malacca; the other I obtained through the courtesy of Drs. Treub and Burck from the herbarium at Buitenzorg, it having been collected many years ago in Amboyna by Teysmann.

Leucolena, n. gen.

Herba fragilis, tenuis, saprophytica, rhizomate elongato fusiformi-tuberoso, horizontali in humo profundo radicibus paucis gracilibus. Caulis erectus aphyllus gracilis, vaginis paucis dissitis. Racemus pauciflorus, flores parvi explanati. Bracteæ lanceolatæ, ovatæ, parvæ. Sepalum posticum lanceolatum obtusum, lateralia connata apicibus liberis, obliqua falcata obovata obtusa sub labello supposita. Petala quam sepalum posticum latiora ovata apice rotundata, sepalo postico adnata usque ad dimidium longitudinis. Labellum basi angusta lamina late obovata triloba; lobi laterales deflexi lati obtusi, medius dentiformis brevissimus. Columna libera erecta, stelidiis longissimis decurvis linearibus subacutis arcuatis. Anthera filamento longiusculo, plana ovata truncata quadrata papillosa. Pollinia 2 aurantiaca piriformia subgranulosa, latere uno canaliculato, disco quadrato truncato unico. Stigma haud profundum. Rostellum truncatum retusum.

Species unica.

Leucolena ornata. (Plate XLIII.) 9–12-uncialis, caule olivaceo, floribus parvis ad 7, sepalo postico et petalis olivaceis medio obscurioribus, sepalis lateralibus olivaceis striis duabus obscurioribus, basi roseis. Labellum album, medio elevato violaceo, $\frac{1}{4}$ unciam longa et lata. Columna alba.

This remarkable little plant was found growing upon a path recently cut through the dense forest of Bukit Sadanen in Malacca. Owing to the clearing of the wood, a number of Saprophytes had appeared on the path; among them were *Sciaphila tenella*, Blume, *Salomonia aphylla*, *Gymnosiphon borneense*, Benn., and an undescribed species of *Lecanorchis*. *Leucolena*, which grew with these plants, seemed to be very local, and I

could only find two plants; but it was well known to the native (a Jaccoon) who accompanied me, as one of the innumerable plants used by women medicinally after confinement.

I am quite unable to suggest any affinity for this plant. That it should be classed with Vandeæ appears to me certain from the structure of the pollinia, which are, however, rather more granular in texture than is usual. The adnation of the petals and dorsal sepal and connation of the two lateral petals are remarkable; but the singular development of the stelidia is the most striking characteristic of the genus. The stelidia are very much of the shape of the rib of some animal, with a small process rising from the curved portion corresponding to the tubercle of the rib. They curve downwards, and reach nearly to the foot of the column, and probably act in some way as guides to the insect fertilizer; for the flower is so expanded that some such arrangement is required to direct the insect towards the stigma and pollen-masses. The lateral lobes of the lip are deflexed, the centre being raised, and the minute middle lobe is curved upwards. Although the sepals and petals are inconspicuous and dull in colour, the bright violet spot in the centre of the lip and the broad white edge make this plant really pretty.

Glossorhyncha, n. gen.

Suffruticosa, gracilis, ramosa, caulibus teretibus virgatis nutantes, pedales vel ultra, vaginis foliorum undique tecti. Folia plura, vaginis ad $\frac{3}{4}$ unciam longis, atro-brunneis, undique pustulosis, ostiis integris, setis brunneis erectis munitis; laminis linearibus acuminatis crassiusculis carinatis atro-punctatis. Flores terminales, singuli in apicibus ramorum sessiles, speciosi, majusculi, tenues. Bractea lanceolata, ovarium breve $\frac{1}{2}$ unciam longum amplectens et celans. Sepala lanceolata acuta, lata, venosa. Petala latiora paullulo breviora. Labellum perparvum subtrilobum ecalcaratum; lobi laterales rotundati erecti, medius sublanceolatus obtusus. Columna brevis crassa, clinandrium valde profundum, margine trilobo denticulato. Anthera oblonga quadrata antice truncata unilocularis, carina brevi in medio loculi vix elevata. Pollinia adhuc desunt. Rostellum linguiforme per longum porrectum carnosum, apice profunde bifido. Stigma transversim latum oblongum, marginibus incrassatis. Capsula brevis oblonga. Columna incrassata et perianthio marcido coronata. Bractea sicca involuta.

Glossorhyncha amboinensis. (Plate XLIV.) Caules pedales, foliis tecti, vaginis $\frac{3}{4}$ unciam longis, laminis unciam longis, $\frac{1}{16}$ unciam latis, carnosulis. Flores 2 uncias lati, albi visi, ovario sessili $\frac{1}{2}$ unciam longo. Sepala $\frac{3}{4}$ unciam longa, $\frac{3}{16}$ unciam lata. Petala $\frac{1}{4}$ unciam lata, sepalis paullo breviora. Labellum basi depressa, margine depressionis incrassato quasi calloso. Capsula $\frac{3}{4}$ unciam longa flava.

Amboina, Mount Salhoetoe, *Teysmann in Hort. Bogor.*

This remarkable plant does not at first sight appear orchidaceous at all, on account of its curious habit. I regret that I have been unable to find any pollinia in the specimens in my possession which might throw some more distinct light on the affinities of the genus. The shape of the rostellum argues a long pedicel with a large gland; and from this and other points I imagine it will prove to be Vandeous, and probably of the section Sarcantheæ. The most noticeable peculiarities in its structure are the singularly large tongue-shaped rostellum, the exceedingly small lip, and the bristles on the edge of the mouth of the leaf-sheath on the side opposite to the lamina. The habit, too, is peculiar, at least in Old-World Orchids; and I do not remember any thing exactly like it.

With this orchid in Teysmann's collection were also many specimens of *Cœlogyne Rumphii*, Lindl., *Corymborchis veratrifolia*, Blume, an *Eria* of the *foliosa* section, and a species of *Bulbophyllum*. The general facies of the Amboinese orchids such as are known is Papuan, and very distinct from those of the Malayan region.

DESCRIPTION OF THE PLATES.

Plate XLIII.

Leucolena ornata, n. sp.

Fig. 1. Complete plant, natural size.
2. Dorsal sepal and petals, from the back, enlarged.
3. Lateral sepals, enlarged.
4. Lip.
5. Column, front view.
6. Column, side view.
7. Pollinia, front view.
8. Pollinia, back view.

Plate XLIV.

Glossorhyncha amboinensis, n. sp.

Fig. 1. Complete plant, natural size.
2. Portion of vagina of leaf with lamina, enlarged.

H.N. Ridley del^t.

J.N. Fitch lith.

LEUCOLENA ORNATA.

H.N.Ridley delt.

J.N. Fitch lith.

GLOSSORHYNCHA AMBOINENSIS.

Fig. 3. Column and lip (anther removed).
4. Side view of column with anther.
5. Front view of column with rostellum raised, and stelidia pushed outwards, enlarged.
6. Anther, front view, enlarged.
7. Anther, back view, enlarged.
8. Capsule, a little enlarged.

Observations on the Protection of Buds in the Tropics. By M. C. Potter, M.A., F.L.S., Lecturer on Botany and Biology at the Durham College of Science, Newcastle-on-Tyne.

[Read 19th June, 1890.]

(Plates XLV.–XLVIII.)

The conditions of climate in different parts of the world with which vegetable life has to contend are so varied, and at times so adverse, that plants are endowed with special means to protect their tender parts in the extreme cases of either heat, cold, or drought. Young leaves and buds are, in the majority of instances, very tender and susceptible to the deleterious effects of the changes of atmospheric conditions under which they live. Hence in cold and temperate regions, where winter and summer alternate, the young and tender buds require protection during the winter, and are therefore protected by means of cataphyllary leaves and stipules against the cold. But, on the other hand, in tropical countries the delicate young leaves need protection both from a dry atmosphere and also from the direct rays of the sun until they are sufficiently developed to resist them. Wiesner *, Feist †, Hofmeister ‡, and Goebel § have described special contrivances by means of which the buds of various plants are protected during the winter from the frost and cold. Treub ‖ has shown the importance of special means of protection against unfavourable conditions in the Tropics, and has given several instances of such protection. Lately, while residing in Ceylon, I had an opportunity of observing some of these means of pro-

* 'Elemente der wissenschaftlichen Botanik,' vol. ii.

† "Ueber Schutzeinrichtungen der Laubknospen dicotyler Laubbäume."

‡ Hofmeister, 'Physiologsche Botanik,' Bd. i.

§ "Beiträge zur Morphologie u. Physiologie des Blattes," Bot. Zeit. 1880.

‖ Handelingen van het eerste Nederlandsch Natur- en Geneeskundig Congress, Amsterdam, 1887, p. 130. Bot. Centralbl. 1888.

tection against heat and drought; and I now propose to give an account of the special contrivances whereby the safety of the young leaves is ensured and how they are protected during their early growth from the direct rays of the sun, and thus saved from harm or partial destruction.

For the purposes of description it will be convenient to consider these special protective contrivances under the following four heads, viz.:—

1. Protection by means of stipules.
2. ,, ,, position assumed when young.
3. ,, ,, shade from older leaves.
4. ,, ,, gum.

1. *Protection by Means of Stipules.*

Artocarpus.

The two species of *Artocarpus*, namely *A. integrifolia*, L., and *A. incisa*, L., both of which grew in the Royal Botanic Gardens at Peradeniya, Ceylon, supplied abundant material for the investigation of the use of the stipules in protecting the young leaves.

In *A. incisa* the stipules of a leaf, as is well known, together form a hood which completely envelops all those leaves which develop subsequently to itself (Pl. XLV. figs. 1 A and B, *a*) upon the same shoot, and thus a stipular hood alternates with every leaf. In this plant, therefore, we have an excellent opportunity to determine whether the stipules are protective or not; and if they are protective, to what degree the leaves enveloped by the hood would be injured by its removal and by the consequent exposure of the developing leaf to the external atmosphere. For this purpose I removed the stipular hood from several young shoots at a time when the hood was exposed to the air and still covering a young leaf, taking care not to injure the enclosed leaf. These young leaves were then allowed to grow, but, consequent upon their too early exposure, they never attained their full and natural size, but were imperfectly developed and permanently deformed. Three of these injured leaves I selected, and at the same time photographed with them a perfectly developed and natural leaf. These four leaves have been accurately reproduced in fig. 2 (Pl. XLV.), in which A is the perfect leaf, and B, C, D the injured ones. A comparison of B, C, D with A proves the necessity of protection by showing to what an extent the leaves were injured by the removal of the stipular hood, and,

further, shows what an important part this plays in the life of the plant, in providing such protection. It will be noticed that these prematurely exposed leaves have suffered a variable amount of injury; and this can, I presume, be explained by the fact that they grew upon different sides of the tree, and thus were unequally exposed to the injurious influences of the sun. On the side which was exposed to the sun, one would naturally expect the leaves to suffer the greatest amount of injury, while those on the opposite side would be less injured, and this is well exemplified in the leaf C; this grew on the south side, and is more imperfectly developed and more deformed than either B or D; these latter grew upon the sides of the tree enjoying a greater amount of shade, and were therefore, to some extent, protected by the other foliage of the tree.

It may be noted that when the stipular hood was removed and the leaf which it covered exposed to the air, in each instance the young leaf was quite normal, and, up to this point, perfectly developed. After the removal of the stipular hood, the young leaf being deprived of its protection, the terminal parts of the leaf, as well as the margins of the lobes, grew imperfectly, owing to the deprivation of sufficient moisture in these parts, which are the furthest removed from the source of water supplied to the leaf by its petiole; and since one of the necessary conditions of growth is the turgescence of the growing cell, the cells at the margin of the leaves, being dried up, were consequently killed.

It may be remarked that, although the majority of trees ceased growing and producing leaves during the dry season, and also that some trees shed their leaves during this period of the year, yet *Artocarpus incisa* continued to produce new leaves during this season; and it does not seem unreasonable to suppose that this may be accounted for by the existence of the protective stipular hoods.

HEPTAPLEURUM.

A good example of protection by means of stipules is afforded by the species of the genus *Heptapleurum*, one of which we will describe. This plant was growing in the Botanical Gardens at Peradeniya; but since it had never flowered, its species had not been determined. In this species of *Heptapleurum* (fig. 3, Pl. XLV., and Pl. XLVI.) the petiole is broadly inserted upon the stem, and at the insertion of the petiole the stipules of each leaf are connate and form a conical projection (fig. 3, C, Pl. XLV.) which rises from

the base of the petiole on its upper surface. This projection is concave on the side nearest the stem and fits close to it. The projections at the apex of the stem are considerably longer than the young internodes, so that they arch over and cover up the growing-point with its undeveloped leaves (fig. 3, A and B, Pl. XLVI.). In this manner the young buds and leaves are completely covered up, and hence are protected from the heat of a tropical sun.

Canarium zeylanicum, *Blume.*

The large tree *Canarium zeylanicum*, Blume, is endemic in Ceylon, and gives a striking example of one of the contrivances in use to protect young buds. A drawing of a branch of this plant is given in fig. 4, A (Pl. XLVI.), in which it is seen that *C. zeylanicum* has imparipinnate leaves, and at the base of the petiole two scales are placed one on each side (fig. 4, A, *a*). It is with these scales that we are concerned. If we turn our attention to the growing-point of the branch (fig. 4, A), it will be noticed that it is covered over with a sèries of scales. The scale in its young condition (fig. 4, B) is an ovate expansion, concave on the inner side, and in this stage it covers over the growing-point; soon, however, it commences to expand laterally, and begins to develop the young leaf at its apex (fig. 4, C). This process continues (fig. 4, D) until the leaf and scales are fully expanded (fig. 4, E). Like the stipules in *Wormia* below described, these scales are cast off as soon as they cease to have any protecting function, and leave behind them scars (fig. 4, A, *b*) upon the sides of the petiole.

By means of these scales the growing-point of each branch is covered over and protected, and the scales not only protect the growing-point, but they also afford protection to the young and growing internodes. In the drawing of the apex of a branch the scales are drawn separated from the internodes for the sake of clearness, but in the natural condition the scales clasp round the internodes and so protect them.

Wormia.

Among the Dilleniaceæ the protection afforded to the bud by stipules is well pronounced in the genus *Wormia*. Treub has already called attention to the means of protection in *W. ochreata*, Teysm. & Binn., but has not given a detailed account; and since the contrivance for protection is rather different in this species from

that in *Wormia triquetra*, Rottb., an account of the latter may not be superfluous.

The leaves of *W. triquetra* are elliptical, with conduplicate venation, and are supported by a petiole about half the length of the lamina. The stipules are ligulate, as long as the petiole and adnate to it, and so form wings on each of its sides, which extend from the base of the lamina to the insertion of the petiole upon the stem. The stipules, when young, arch over and cover up entirely the leaf which will be developed next in succession until it is ready to unfold, and so the young and unexpanded leaves are effectually protected. This will be better understood if we trace the life-history of one of the leaves. We will commence at the stage when the young leaf is entirely covered up (fig. 5, A, Pl. XLVII.); in this stage it is noticed that the petiole is swollen (fig. 5, A, *a*) on its upper surface; and this swelling is caused by the stipules of the expanded leaf arching over and covering up the next youngest leaf. At the stage a little more advanced we see the young leaf, still unexpanded, just emerging from the covering stipules (fig. 5, B). The young leaf in this condition is nearly as long as the petiole of the leaf which was developed immediately before it, so that the young leaf is entirely covered over. The next stage (fig. 5, C) shows the leaf after it has completely emerged from the stipules and is just beginning to expand. The leaf is now strong enough to resist the ordinary external conditions, and soon attains its full development. Its petiole (fig. 5, C), it will be noticed, has a similar swelling to the one already described; this is caused in the same manner by its stipules covering over the next youngest leaf, and so on. Thus the same story is repeated for every leaf, and each leaf in turn has the benefit of stipular protection from an older leaf.

The history of the stipules after they have served as protecting organs is interesting. At first, that is while they are covering over a young leaf, they are green; but when the leaf has emerged from them, they soon turn brown and wither, and are of no further use to the plant. The stipules, therefore, are cast off, the separation of petiole from stipule commencing at the base of the petiole and proceeding to the lamina (Pl. XLVII. fig. 5, B and D). This separation proceeds until the stipules are completely separated from the petiole; they then fall off, and consequently two long scars are left on each side of the petiole, showing where the stipules had been.

Sarcocephalus.

One of the chief characteristics of the Order Rubiaceæ is the presence of stipules, and hence in this Order one naturally looks for some examples of their use as protective organs.

The example we have chosen for description is *Sarcocephalus esculentus*, Afz. In this genus, and in many genera of the Rubiaceæ, at each node two leaves opposite to each other are borne, and also two stipules alternating with them, and these stipules successively cover over the growing-point (Pl. XLVII. fig. 6, A). This is better seen when one stipule has been removed (fig. 6, B) and the growing-point deprived of half its protective covering. Each pair of leaves is in this manner covered up until they are sufficiently developed to be allowed to expand. The stipules are deciduous, and fall off when their protective function is accomplished.

2. *Protection by the Position assumed by Young Leaves.*

One of the external harmful conditions against which young leaves have to be guarded is, as we have already seen, the heat of the sun. Now the amount of heat received by a given surface from the sun varies directly as the sine of the angle which the incident heat-rays make with the given surface; so when a leaf is placed horizontally and the sun is vertically over it, the leaf receives the maximum amount of heat (because $\sin 90°=1$); and in the Tropics one notices a great many leaves which are burnt or scorched by being placed in a horizontal position. But, on the other hand, when a leaf is placed vertically and the sun is directly over it, the leaf receives the minimum amount of heat (because $\sin 0°=0$). Hence we find that many leaves, when they are young and still growing, are placed in a vertical position.

The arrangement above explained to guard a leaf from excessive heat can be well studied in many of the Palms; and from among this Order we will select the Cocoa-nut (*Cocos nucifera*) for illustration.

A fully developed Cocoa-nut leaf is pinnate, with each pinna V-shaped, the apex of the V pointing upwards; but when quite young each pinna is folded, so that its halves lie flat upon each other, and all the pinnæ are closely pressed together upon each side of the rhachis, and the whole projects vertically upwards like a pole from the apex of the tree. In this condition the leaf

remains until nearly full-grown, its vertical position affording it sufficient protection. But as the pinnæ of the leaf become stronger, they expand gradually and open out; for a considerable time, however, the rhachis remains vertical, but as time goes on it gradually bends over and assumes first a horizontal position, and then sinks until it hangs downward against the sides of the tree. When in the horizontal position I have often seen the pinnæ very much scorched and destroyed by the sun.

The Monocotyledons afford very many instances of this kind of protection, among which we may mention the Aroideæ, *Musa*, *Canna*, Palmæ, *Agave*, &c.; among the Dicotyledons, too, we find many similar instances. Treub * has already drawn attention to the protection gained to species of *Brownea* and *Jonesia*, and to *Amherstia nobilis*, Wall., by their young leaves hanging down when young; and to these we may add *Durio zibethinus*, Linn., and *Galactodendron utile*, Humb. & Bonpl.

3. *Protection from Older Leaves.*

When any leaf has become strong enough to resist both the sun's heat and the deleterious atmospheric conditions, it is not surprising to find that it should be made useful in protecting younger leaves; and so I have been able to find instances where the older leaves overlap to form a kind of shield to roof over and so protect the younger leaves, or are of such a shape and assume such positions that they are able to play a very important part in protecting younger leaves.

A very good example illustrating how older leaves can be so arranged as to effectually cover over the young leaves and growing-point is found in *Uvaria purpurea*, Blume. A front and also a back view of a shoot of this plant is shown in fig. 7, A and B (Pl. XLVIII.), where A is the front view and B the back view of a similar shoot. The shoots themselves are in this plant slightly inclined to the vertical, so that by this means the older leaves are protected from the sun's heat. On examining the front view (fig. 7, A), we see that the three leaves *a*, *b*, *c* are so arranged that they completely cover over the growing-point and its younger leaves, so that these latter are completely shielded; while the back view (fig. 7, B) shows how the younger internodes, with their smaller leaves, are hidden behind the large leaves. The young leaves, as they attain to their mature size, assume the

* Bot. Centralbl. vol. xxxv. p. 239.

same relative positions, and so protect other young leaves, and so on.

Galactodendron utile affords also an example of this mode of protection, the young and tender leaves being protected by older ones; and further protection is also gained by the tender leaves assuming a vertical position until sufficiently strong to resist the atmospheric conditions.

Gossypium.

Another very interesting case of older leaves protecting the younger ones is found in the various species of the genus *Gossypium*. In this genus the leaves are cordate, with rather long petioles, which, for some time after the leaf has expanded, assume a position only slightly inclined from the vertical; the lamina forms an acute angle with the petiole, and is so arranged that in the young condition it hangs nearly vertically (Pl. XLVII. fig. 8, A, *b*) downwards; thus the lamina of each leaf makes an acute angle with the axis of the branch on which it is borne In this way each leaf, in its turn, stands nearly over the actual growing-point (fig. 8, B and C), and shades all leaves younger than itself; and here we see the advantage which these plants gain from the cordate base of their leaves, namely, that the lamina being continued backward is able more effectually to shade the growing-point. The manner in which the growing-point can be shaded is seen in fig. 8, B and C, which are taken from photographs of living plants in which the camera was placed directly over the shoot. In fig. 8, B, the young leaf *b* is partially seen; but all leaves younger than *b* and the growing-point are invisible, and hence completely shaded; and in fig. 8, C, the leaf *a* entirely shades the growing-point.

Begonia.

A still more interesting case of this kind of protection is found in the genus *Begonia*. The leaf of the Begonias, it is well known, is unsymmetrical (Pl. XLVIII. fig. 9, A), the want of symmetry being caused by the base of the lamina being semicordate; one side of the base is largely developed, while the other side remains almost undeveloped. Just as in the case of *Gossypium* previously described, the leaves are so arranged that the lamina of the older leaves shades over the younger ones. Fig. 9, C,

which is a drawing of a branch in a vertical position, shows the arrangement of the leaves, and how the leaf *c* is effectually shaded by the leaves *a* and *b*; and fig. 9, B, which is taken looking straight down upon the apex of another shoot, shows how effectually all the leaves younger than *f* are shaded and protected, and at the same time how the leaf *f* receives a considerable amount of shade and therefore of protection.

I investigated many species of *Begonia* growing wild, and always found the same result, namely, that the leaves were so arranged that the young leaves received a great deal of shade, and that the peculiar shape of the old leaf helped considerably in shading the younger leaves.

We have now an explanation of the curious shape of the *Begonia*-leaves, viz. to take part in the protection of younger leaves; and although this peculiar shape may have some other function, yet at all events it is useful as an organ of protection.

In many species grown in greenhouses in this country this arrangement is not clearly marked, the leaves being drawn to one side according to the prevailing direction of the light, while in its natural state the plant would be equally illuminated on all sides.

4. *Protection by Means of Gum.*

Treub, in the paper above quoted, mentions *Tabernæmontana* and *Lactaria* as genera in which the buds are protected by means of a gummy secretion which covers over the growing-point, and to these we may add various species of *Gardenia* and *Lasianthera apicalis*, Thw.

The case of *Tabernæmontana dichotoma*, Roxb., is especially interesting. The buds of this plant are covered over with a gum which does not completely harden, but remains in a semifluid condition; and as the leaves previously covered up grow and expand, the gum remains attached to their edges and stretches as a thin film between them; and so the next youngest leaves are for a certain time enclosed in a small four-sided chamber, two opposite sides of which are formed by two leaves, and the other two opposite sides by a thin film of gum. This gum is eventually ruptured and the same process is repeated.

I had intended to have worked out completely the secretion of

gum in these plants; but on my return to England I found that my friend Mr. Percy Groom had already done considerable work on this part of the subject. I therefore gave to him the material necessary to finish his investigations.

DESCRIPTION OF PLATES XLV.-XLVIII.

Fig. 1. *Artocarpus incisa.* A, a shoot showing leaves and stipular hood (*a*). B, end of a shoot showing leaf and inflorescence (*b*) just emerging from the stipular hoods (*a*).

Fig. 2. *Artocarpus incisa.* A, perfect leaf. B, C, D, leaves damaged by the sun when stipular hood has been removed.

Fig. 3. *Heptapleurum.* A, shoot with leaves. B, shoot showing growing-point protected by the stipules. C, base of petioles with stipules.

Fig. 4. *Canarium zeylanicum.* A, end of a shoot, showing protective scales. B, C, D, E, drawings showing the development of a leaf.

Fig. 5. *Wormia triquetra.* A, end of a shoot with young leaf enclosed in the stipules at *a*. B, young leaf just emerging from stipules. C, young leaf fully emerged. D, drawing showing the stipules being cast off.

Fig. 6. *Sarcocephalus esculentus.* A, shoot with leaves and growing-point covered with stipules. B, growing point with one stipule removed. C, a stipule.

Fig. 7. *Uvaria purpurea.* A, front view of a shoot. B, back view of a shoot.

Fig. 8. *Gossypium.* A, shoot seen in an erect position. B and C, shoots, seen from above.

Fig. 9. *Begonia.* A, leaf. B, shoot, seen from above. C, shoot seen in a vertical position.

A.R. Hammond del.

PROTECTION OF BUDS.

Hanhart lith

A.R.Hammond del. Hanhart lith.

PROTECTION OF BUDS.

A R Hammond del.

Hanhart lith.

PROTECTION OF BUDS.

A. R. Hammond del.

Hanhart lith.

PROTECTION OF BUDS.

On Lichens collected in the Colony of Victoria, Australia. By Rev. F. R. M. Wilson. (Communicated by W. Carruthers, Esq., F.R.S., F.L.S.)

[Read 16th April, 1891.]

(Plate XLIX.)

No previous paper has been published on the Lichens of Victoria, so far as the writer is aware; and, with the exception of a few specimens in the Melbourne Botanical Museum named by Krempelhuber and J. Mueller, and a few collected along the coast by various persons and named by Nylander and others, the lichenology of Victoria has hitherto been a blank. The paucity of previous information will account for the large number of species and varieties which are here named as new.

The microscopical examination in every case was made with a good magnifying-power of 275 diameters, from which the drawings have been enlarged to 1000 diameters. In these examinations it has been found that the spores of Victorian Lichens are usually smaller than those of the same species described by European lichenologists. It should be mentioned, however, that most of the plants examined were gathered during a cycle of abnormally dry seasons, and that the spores of at least some Lichens gathered after a continuance of wet weather proved to be nearly half as large again as those from specimens collected in the same spot after a drought.

In determining the species much help has been obtained from the Lichen herbaria in the Melbourne Botanical Museum, especially from Hepp's collection, and from the specimens authenticated by J. Mueller. Besides which the following authorities have been consulted:—Acharius's 'Lichenographia Universalis,' 1810, and 'Synopsis Methodica Lichenum,' 1814; Nylander's 'Synopsis Methodica Lichenum,' 1858; Leighton's 'Lichen Flora of the British Isles,' 3rd edition, 1879; Hooker's 'Handbook of the New Zealand Flora'; and various papers in the Linnean Society's Transactions during many years.

Fam. I. Byssaceæ.

It is probable that there are representatives of this family which have eluded observation from their obscurity and their close affinity to the Algæ. It is only after much perplexity and

repeated comparison with Hepp's specimens and drawings that the following species has been classed with the *Stigonemata*:—

1. STIGONEMA EPHEBEOIDES, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 1.)

Thallus fusco-ater opacus pulvinato-contextus filiformis tenellus, subsecundc-ramosus, præsertim ad apicem. Alt. ad 3 mm., crass. ad ·1 mm. adtingens.—Habitat super saxa granitica subalpina in Mt. Macedon (alt. 3400 ped.).

Cortex e membrana tenuissima olivacea constat, per quam visæ sunt, saltem in ramulis juvenilibus, cellulæ transverse ordinatæ, granula gonima 1–3 vel plura continentes. Ramuli senescentes minus translucidi, atque a granulis plus prominentibus magis rugulosi facti sunt. Granula gonima dilute olivaceo-virentia sunt, et magnitudine formaque valde diversa, plerumque ·01 mm. diam. Supra thallum et concolora et mox separabilia inveniuntur organa minuta lenticularia, ·2 mm. diam., quorum textura videtur eadem quæ thalli.

Fig. 1 exhibet ramuli thallini apicem.

Fam. II. COLLEMACEI.

This family is well represented in Victoria, considering the dryness of the climate. Twenty-three species have been found, of which eleven seem to be new to science. Of the rest four are new varieties. One of the new species has been assigned to Wallroth's obsolete genus *Obryzum*, owing to its unmistakably endocarpoid apothecia and its cellular thalline cortex. Some of this family are abundant enough, especially *Lichina confinis*, *Leptogium olivaceum*, *L. tremelloides* var. *azureum*, *L. Victorianum*, and *L. Burgessii*. It is notable that the Victorian *Collemata* belong chiefly to the narrow-spored section (*Synechoblastus*) of that genus, which is usually the least numerous.

2. LICHINA CONFINIS, *Ach.*

Frequens supra scopulos maritimos ad mare Australe et ad sinum Port Phillip, aquâ marinâ inundata.

3. SYNALISSA MICROCOCCA, *Born. et Nyl.*

Abundans supra muscos et rupes subalpinos in Mt. Macedon (alt. 3400 ped.).

4. COLLEMA PLUMBEUM, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 2.)

Thallus plumbeus parvus complicatus membranaceus rotundolobatus, lobis undulatis. Apothecia minuta sæpe conferta rufo-

brunnea sessilia plana, margine thallino cincta. Sporæ ellipsoideo-fusiformes, 5-septatæ, adhuc longitudinaliter divisæ, long. ·02 mm., lat. ·004 mm. Granula gonima oblongo-globosa, long. ·003–·005 mm. moniliformiter concatenata, iodo vinose lutea. Gel. hym. iodo cærulea.—Habitat supra muscos ad arboris corticem in Warburton.

Fig. 2. Spora.

5. Collema (§ Synechoblastus) atrum, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 3.)

Thallus ater mediocris, ad diam. 1·5 poll. attingens, complicato-squamosus, ambitu lobatus crassus cartilagineus granulato-corrugatus. Apothecia atra vel obscure rufa vel interdum albida, margine thallino integro cincta, ad diam. 1 mm. attingentia. Sporæ ovatæ vel fusiformi-ovatæ uno vel utroque apice acuminatæ 3–4-loculatæ, long. ·018–·026 mm., lat. ·005–·006 mm. Thecæ clavatæ, iodo intense cæruleæ. Paraphyses graciles confertæ.—Habitat ad rupes calcareas maritimas in Warrnambool.

Fig. 3. Sporæ tres.

6. Collema (§ Synechoblastus) congestum, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 4.)

Thallus ater vel atro-fuscus, parvus, lat. poll. attingens, cartilagineus difformi-lobatus, lobis rotundis undulatis ambitu elevatis incrassatis crenatis. Apothecia atra vel pallide aut obscure rufa, mediocria, diam. 2 mm., plana margine incrassato cincta, demum convexa immarginata. Sporæ cylindricæ vel ellipsoideo-cylindricæ, interdum curvatæ, sæpe apicibus acuminatæ, simplices vel uniseptatæ, 2–5 loculos continentes, long. ·017 mm., lat. ·0035 mm. Paraphyses crassæ inarticulatæ. Gel. hym. iodo cærulescens, protoplasma thecarum intense cæruleum. Granula gonima in alveolis conglomerata in quovis 2 vel 3 vel pluria, non moniliformia.—Habitat supra muscos &c. ad rupes calcareos maritimos in Warrnambool.

Fig. 4. Sporæ quatuor.

7. Collema glaucophthalmum, *Nyl.*
Haud infrequens in locis variis.

8. Collema nigrescens, *Ach.*
Haud infrequens, sæpe socium *C. glaucophthalmi.*

9. Collema leucocarpum, *Tayl. & Hook.*
Frequens ad arbores et rupes in locis variis.

10. COLLEMA LEUCOCARPUM, *Tayl.*, var. MINUS, *F. Wils.*

Multo minus et obscurius quam typus, quoad thallum et apothecia. Sporæ long. circa ·03 mm.—Habitat ad arbores prope lacum Wat Wat, Gippsland.

11. COLLEMA (§ SYNECHOBLASTUS) SENECIONIS, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 5.)

Thallus viridis aut fusco-virens aut olivaceus, subtus cæruleovirens, tenue membranaceus, lævis nitidus aut nitidiusculus vel sæpius granulato-rugulosus, mediocris, 2–3 poll. attingens, rotundo-lobatus, lobis imbricatis undulato-crispis margine adscendenti. Apothecia rufa vel testaceo-rufa mediocria, circa 1 mm. sæpe conferta plana vel convexiuscula, margine thallino tenui integro cincta. Sporæ elongato-fusiformis rectæ vel arcuatæ vel spiraliter contortæ, 3–9-septatæ, long. ·03–·05 mm., lat. ·004–·008 mm. Gel. hym. iodo cærulescens. Gran. gonima oblonga vel reniformia, long. ·1–·2 mm. vel subglobosa, diam. circa ·1 mm.—Habitat ad corticem *Senecionis Bedfordii* in ramis horizontalibus vel truncis inclinatis, raro et nonnihil minus ad corticem *Prostantheræ lasianthi*, in Mt. Macedon, et Lakes Entrance, Gippsland.

Thallus juvenilis est pertenuis nitidus quasi tenuis pigmenti membrana.

Fig. 5. Sporæ tres.

12. COLLEMA (§ SYNECHOBLASTUS) QUADRILOCULARE, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 6.)

Thallus fusco-olivaceus vel nigricans membranaceus adherens, lobatus ambitu crassior crispatus. Apothecia mediocria atra vel rufo-atra, margine thallino integro cincta plana vel concaviuscula conferta. Sporæ cylindricæ in utroque apice rotundatæ aliquando curvatulæ, 3-septatæ, long. ·02–·03 mm., lat. ·003–·005 mm. Paraphyses graciles inarticulatæ. Gran. gon. moniliformia aut interdum in alveolis gelatinosis quaterna conglomerata.—Habitat supra muscos ad rupes graniticos subalpinos, in Mt. Macedon alt. 3400 ped.

Fig. 6. Sporæ duæ.

13. LEPTOGIUM OLIVACEUM, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 7.)

Thallus olivaceus, subtus pallidior vel cinerascens, lævis firmus rotundo-lobatus undulatus. Apothecia rufa vel fusco-rufa, plana demum convexa, margine thallino tenui cincta. Sporæ fusiformi-ellipsoideæ, long. ·013 mm., lat. ·004 mm., 3–5-septatæ, adhuc

longitudinaliter divisæ.—Habitat inter muscos ad rupes graniticos in Traawool et Beaconsfield.

Persimile *Collemati furvo* sed cortice thallino haud dubie cellulari distinguitur. Gran. gon. moniliformi cohærentia. Gel. hym. iodo cærulescens.

Fig. 7. Spora.

14. Leptogium olivaceum, var. granulatum, *F. Wils.*

Thallus olivaceus vel fusco-olivaceus, passim plumbeus, subtus pallidior firmus mediocris, lat. poll., lævis sæpius prope centrum vel omnino granulatus. Cætera ut in typo.—Habitat ad arborum cortices in Warrnambool et Kew et Gippsland; frequens.

15. Leptogium olivaceum, var. limbatum, *F. Wils.*

Thallus ambitu crispatus et isidioso limbatus. Apothecia invisa. Habitat ad aborum cortices in Warrnambool.

16. Leptogium olivaceum, var. isidiosum, *F. Wils.*

Thallus plumbeo-cærulescens, passim olivaceo tinctus membranaceus tenuis plicato-undulatus plus minus isidio cæsio vel obscure plumbeo vestitus. Sterilis.—Habitat ad arborum cortices in Gippsland et Warrnambool.

17. Leptogium biloculare, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 8.)

Thallus plumbeus membranaceus parvus (semipol.) laciniato-lobatus, lobis sinuatis undulatis. Apothecia pallide rufa minuta, lat. ·2–·7 mm., margine thallino prominulo cincta. Sporæ fusiformi-ellipsoideæ, biloculares, long. ·015 mm., lat. ·006 mm. Gel. hym. iodo cærulescens.—Habitat ad arboris corticem in sylva montana, Mt. Macedon.

Fig. 8. Spora.

18. Leptogium sinuatum, *Koerb.*

Haud infrequens ad rupes muscosas prope rivulos in Mt. Macedon et Lorne et Kilmore.

19. Leptogium lacerum, *Ach.*

Infrequens ad rupes muscosas prope rivulos in Mt. Macedon et Lorne et Upper Beaconsfield. Dubium.

20. Leptogium lacerum, var. pulvinatum, *Hoffm.*

Rarum ad terram, Kew.

21. Leptogium tremelloides, *Fr.*

Supra muscos ad arboris corticem, Warburton.

22. Leptogium tremelloides, var. azureum, *Nyl.*
Frequens in locis plurimis.

23. Leptogium dactylinum, *Tuck.*
Haud infrequens supra muscos ad saxa et rupes in rivulis, prope Cobden et Lorne.

24. Leptogium Pecten, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 9.)
Thallus minutus squamuliformis plumbeus vel brunneus tenuissimus ambitu digitato-crenatus sæpe pulvinato-confertus. Apothecia rufescentia, cum thallo comparata majuscula, lat. 1·5 mm., concava margine pallido tenui cincta, sæpe immarginata. Sporæ subellipsoideæ, long. ·016–·024 mm., lat. ·008 mm., 3-septatæ, loculis centralibus sæpe longitudinaliter divisis.—Habitat ad arborum cortices emortuos in Mordialloc, et Mt. Macedon et Glenmaggie; infrequens.

Fig. 9. Sporæ duæ.

25. Leptogium Victorianum, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 10.)
Thallus obscure plumbeus, passim rufo-fuscus, subtus fere concolor vel subcinerascens, magnus, 3 pol. et ultra, rotundo-lobatus, lobis undulatis, firmus plus minus confuse rugulosus membranaceus sed in lobis veteribus crassus et passim fusco-furfuraceus quasi cortice privatus interdum squamulis vestitus. Apothecia mediocria interdum majuscula rufa vel fusco-rufa, margine thallino (interdum excluso) sæpius plicato vel granulato vel breve lacinato cincta. Sporæ ovoideo-fusiformes, apicibus sæpe acuminatis, long. ·013–·017 mm., lat. ·005–·006 mm., typice 3-septatæ plerumque loculis centralibus longitudinaliter vel oblique divisis. Gran. gon. moniliformiter concatenatæ.—Habitat inter muscos ad arbores et rupes. Abundans in locis montanis, Mt. Macedon et Black Spur etc.

Affine *L. chloromelo*, Sw., et forsitan ejus varietas.

Fig. 10. Sporæ duæ.

26. Leptogium phyllocarpum, *Pers.*
Abundans in locis maritimis ad mare Australe.

27. Leptogium Burgessii, *Mont.*
Frequens ad rupes et arborum cortices in locis multis.

28. Leptogium limbatum, *F. Wils.*, sp. nov.
Thallus plumbeo-cærulescens vel plumbeus, passim rufo-fuscescens membranaceo-dilatatus majusculus, ad 2–3 poll. attingens,

rotundo-lobatus undulatus ambitu inflexo sinuato pro magna parte limbo squamoso ornatus interdum bullatus in bullis spermagonibus confertis, subtus concolor parce albo tomentellus ambitu late nudus. Apothecia invisa.—Habitat ad arborum cortices in Mt. Macedon.

Speciosum. Affine *L. inflexo,* Nyl., sed distat thallo lobato et limbato et infra concolore.

29. Obryzum myriopus, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 11.)

Thallus cinerascenti-plumbeus vel cæruleo-plumbeus, parvus, circa poll., rotundo-lobatus profunde fissus, lobis imbricatis marginibus decurvis minute confuse rugulosus, subtus rhizinis vellereis sæpe fasciculatis albis passim cæruleo-nigricantibus dense vestitus. Apothecia endocarpoidea minuta, lat. ·2 mm. extus tanquam tubercula depressa fuscescentia vel obscura in lobis thalli dispersa hic illic sat conferta. Sporæ 8næ incolores, ellipsoideo-fusiformes, long. ·013 mm., lat. ·004 mm., 3-septatæ, iodo succineo coloratæ. Paraphyses discretæ. Gran. gon. oblonga, long. ·015 mm., bina in cellulis moniliformibus vel dispersis minute granulata maculata. Cortex cellulosus.—Habitat super arboris corticem inter Jungermannias in sylva umbrosa prope Warragul, Gippsland. Semel invenitur in Victoria, sed frequenter forma isidiosa sterilis in Queensland. Rhizinæ fasciculatæ in ambitu thalli simulant pedes myriopodis; hinc nomen.

Fig. 11. Spora.

Fam. III. Myriangiacei.

Two species of *Myriangium* have been found in Victoria, one of which is new to science. The new species has several peculiarities, which may give a little help in elucidating the affinities of this strange family.

The whole plant is covered with scyphophoroid apothecia standing out in all directions, and of various sizes and stages of development. The epithecium is almost identical in texture with the epithallus, but is generally concave and slightly rufescent. In old apothecia it is worn into cavities, which give it a granulato-rugulose appearance. The spores are longer and narrower than those of the species hitherto known, and in general form resemble those of *Collema multipartitum* figured by Nylander in his 'Synopsis.' Both thallus and apothecia contain granular gonimia, which are usually, if not invariably, conglomerate. When a dried

specimen of this lichen is submerged in water, there arise from it on all sides streams of minute air-bubbles for a considerable time, showing the porous nature of the plant. It does not very appreciably increase in size when moistened, as the *Collemacei* do. When it is wet or bruised, a marked scent like that of some fungi is perceived, but this character it has in common with many other lichens, especially among the *Cladoniei*.

30. MYRIANGIUM DURIÆI, *Berk. et Mont.*

Infrequens in Mt. Macedon et Sandringham. Specimina a Victoria sporas minores habent quam ea a Nylandro descripta; long. ·017–·023 mm., lat. 006–·009 mm.; sicut specimina a Queensland; de quibus Dr. Knight scripsit "The spores are usually smaller, and the cells constituting the mass of the thallus are darker and more opaque than those of European growth."

31. MYRIANGIUM DOLICHOSPORUM, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 12.)

Thallus ater, parvus, lat. 2–5 mm., alt. circa 2 mm., pulvinatus opacus vel nitidiusculus inæqualis. Apothecia fere thallum circumtegentia et concolora plana vel concava, epitheciis subrufescentibus, lat. 1 mm. attingentia, marginibus thallinis rotundo-obtusis cincta, elevata vel stipitata stipitibus interdum ad long. 1 mm. productis deorsum attenuatis. Thecæ sphæroideæ in epithecii substantia cellulari dispersæ. Sporæ 8næ incolores cylindricæ simplices arcuatæ ad apices subacuminatæ minute guttatæ in axi longitudinali, long. ·04 mm., lat. ·006 mm. Gran. gon. diam. ·002–·007 mm. Textura cellulosa fusca, cellulis diam. ·003–·005 mm.—Habitat ad ramulos *Hymenantheræ Banksii* in Maffra, Gippsland. Facile dignotum apotheciis stipitatis et sporarum forma.

Fig. 12. Sporæ duæ.

Fam. IV. LICHENACEI.

Tribe CALICIEI.

Dr. Nylander, in his 'Synopsis Methodica Lichenum,' says of the geographical distribution of this tribe, "hemisphæram borealem præprimis inhabitantes." "In Europa adsunt 33, in Gallia 27, in terris Scandinavis 25, in America boreali saltem 27, in hemisphæra autem australi cognita sunt solum 5, quarum 2 in boreali deficiunt. Species totius telluris computatæ inveniuntur 40." Exploration in Victoria leads to the conclusion that

this tribe is as largely represented in the Southern as in the Northern hemisphere. Probably the minuteness of the plants has caused them to be overlooked by collectors visiting the Southern hemisphere. As far as Victoria is concerned, they seem to have been overlooked altogether. The writer was the first to publish the discovery in this colony of a lichen of this tribe; and he has found them in great abundance in very many places and of many kinds.

The following list contains 31 varieties, if not species, found in Victoria, of which 27 at least seem to be new to science. On comparing them with Nylander's descriptions, the Victorian plants, as a rule, seem to have somewhat smaller spores and a more developed thallus than those found elsewhere. The thalli of *Calicium niveum*, *C. flavidum*, and *C. roseo-albidum* are specially remarkable for their thickness. It is notable also that the species which in other lands grow on the wood of the oak, in the absence of that tree in Victorian forests choose the eucalypts, whose timber is similarly dense. All the *Calicei* hitherto found in Victoria grow on dead wood or dead bark, or the thallus of other lichens. None are saxicole. The following descriptions and relative drawings are the result of repeated and careful autopsy.

32. Sphinctrina microcephala, *Nyl.*, var. tenella, *F. Wils.*

Apothecia nigro-fusca nitida tenella, alt. 3 mm., capitulis turbinato-globosis (diam. ·1 mm.) in stipitibus (crass. ·05 mm.) elevatis, excipulis pyrenodeis. Sporæ simplices nigricantes fusiformi-globosæ nonnullæ difformi ellipsoideæ, long. ·01 mm., parietibus crassiusculis.—Habitat super Pertusariam quandam ad ramulos *Hymenantheræ Banksii* in Maffra, Gippsland.

Similis *S. microcephalæ* a Nylandro descriptæ (Meth. Syn.) sed stipites speciminum Victorianorum sæpius longiores et graciliores et capitula minora et sporæ minutiores sunt. In plagis paucis minutis (diam. 6–12 mm.) conferta inventa est. Specimina similiora typo inventa sunt prope Sydney, New South Wales, etenim prope Brisbane, Queensland, non conferta sed sparsa et in plagis majoribus quam var. *tenella.*

P.S. Typus nuper minutus in Maffra, Gippsland.

33. Calicium chrysocephalum, var. filare, *Ach.*

Thallus obsoletus. Apothecia minuta, alt. ·7–1 mm., stipitibus gracilibus circa ·05 mm. crass., capitulis turbinatis citrino suf-

fusis, massa sporali fusca aliquando ad alt. ·25 mm. protrusa. Sporæ dilute fuscæ, sphæricæ, circa ·004 mm. diam.—Habitat ad Eucalyptos decorticatos putrescentes in Lakes Entrance, Gippsland.

P.S. Typus quoque inventus in Gippsland.

34. Calicium jejunum, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 13.)

Thallus albidus vel cinerascens. Apothecia tota nigra stipitibus gracilibus alt. 1 mm., vel paullo altioribus, crass. circa ·1 mm. aliquando furcatis, capitulis lentiformibus vel subturbinatis lat. ad ·5 mm. attingentibus. Sporæ dilute nigrescentes, fusiformi-ellipsoideæ, simplices, pariete crasso linea nigra definitæ, long. ·006–·009 mm., lat. ·004–·005 mm., a latere visæ bacillares crass. ·0015.—Habitat ad Eucalyptos decorticatos in Lakes Entrance, Gippsland.

Fig. 13. Sporæ duæ.

35. Calicium niveum, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 14.)

Thallus niveo-albus crassus effusus. Apothecia minuta, alt. ·5 mm., stipitibus gracillimis, crass. circa ·05 mm., infra hyalino-albidis supra fuscis aut nigris vel totis fuscis aut nigris aliquando uno- vel pluri-furcatis. Capitulis hemisphærico-lenticularibus nigris, lat. circa ·25 mm., interdum in lobis duobus vel pluribus divisis. Sporæ dilute nigrescentes fusiformi-ellipsoideæ simplices, long. ·004–·006 mm., lat. ·002–·005 mm., compressæ, transverse visæ fere bacillares vel truncato-oblongæ crass. ·0015 mm. parietibus crassis. Gel. hym. iodo vinose lutescens.—Habitat ad corticem emortuum Eucalyptorum vivorum in Maffra et Lakes Entrance, Gippsland.

Simile est colore formaque sporarum *C. parietino* (Nyl. Syn. Meth. tab. v. fig. 27) at earem magnitudine *C. pusiolo* (Nyl. Syn. Meth. p. 158); haud loquitur autem Nylander de sporarum compressione visa in omnibus sporis *C. nivei* multis examinatis. Simile quoque stipite est *C. pusiolo*, et similiter habitat. Forsitan ejus varietas.

Fig. 14. Sporæ duæ.

36. Calicium Victoriæ, *C. Knight*, sp. nov. (Pl. XLIX. fig. 15.)

Thallus albus vel albidus vel cinerascens plus minus indicatus effusus. Apothecia tota nigra, alt. ·5–1 mm., stipitibus gracilibus crass. circa ·1 mm. aut paulo crassioribus ad basin, capitulis tur-

binato-lentiformibus vel hemisphærico-lentiformibus, lat. ad ·25 mm. attingentibus. Sporæ fuscæ fusiformi-ellipsoideæ simplices, long. ·005–·008 mm., lat. ·002–·003 mm., pariete crassiusculo extus a linea obscura definitæ.—Habitat ad Eucalyptos emortuos decorticatos in Kew et Croydon et Warrnambool, etc.: haud infrequens. Affine *C. parietino.*

Fig. 15. Sporæ duæ.

37. CALICIUM PARVULUM, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 16.)

Thallus albus subdeterminatus. Apothecia tota nigra, alt. ·4 mm., stipitibus gracilibus crass. ·05 mm., capitulis lentiformibus lat. ·16 mm. Sporæ dilute nigrescentes ellipsoideæ simplices, long. ·003–·006 mm., lat. ·0015–·0025 mm., parietibus tenuibus nigris.—Habitat ad Eucalyptos emortuos decorticatos in Maffra et Mt. Macedon. Facie est albarium tenue in quo apothecia pernigra etsi minutissima mox visa sunt. Sporæ linea exteriore nigra notatæ sunt ut eæ *C. Victoriæ*, cujus forsitan hic lichen sit varietas minuta.

Fig. 16. Sporæ duæ.

38. CALICIUM CONTORTUM, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 17.)

Thallus albidus tenuissimus. Apothecia tota nigra, alt. 1 mm., stipitibus gracilibus crass. ·1mm. contortis, capitulis hemisphærico-lenticularibus. Sporæ dilute nigrescentes fusiformi-ellipsoideæ simplices, long. ·004 mm., lat. ·0014–·002 mm.—Habitat ad Eucalyptos emortuos decorticatos in Metung, Gippsland. Assimile *C. Victoriæ*, sed distinguendum capitulis minoribus et sporis minutioribus arctioribus coloreque alio.

Fig. 17. Sporæ duæ.

39. CALICIUM GRACILLIMUM, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 18.)

Thallus macula alba indicatus. Apothecia tota nigra, alt. ·8 mm., stipitibus gracillimis crass. circa ·06 mm., capitulis minutis lat. ·1 mm. turbinato-lentiformibus. Sporæ ellipsoideæ vel fusiformi-ellipsoideæ, long. ·001–·002 mm., lat. ·0006–·001 mm., uniseptatæ.—Habitat ad *Asterem argyrophyllum* decorticatum putrescentem in Mt. Macedon.

Fig. 18. Sporæ tres.

40. Calicium deforme, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 19.)

Thallus cinerascens tenuis granulosus. Apothecia nigra, granulis thallinis et aliis deformata, alt. 1 mm. vel paullo altiora, stipitibus crass. ·2 mm., capitulis turbinato-lentiformibus lat. ad ·5 mm. attingentibus; massa sporali nigra protrusa, interdum uno latere valde extensa. Sporæ nigrescentes fusiformi-ellipsoideæ, long. ·006–·008 mm., lat. ·0025–·004 mm., uniseptatæ, septo plerumque minus distincto.—Habitat ad Eucalyptos decorticatos putrescentes in Metung, Gippsland.

Apothecia insolita in hoc genere inconcinna mox granulos aut particulas alienas retinent, quasi glutinosa.

Fig. 19. Sporæ quatuor.

41. Calicium roseo-albidum, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 20.)

Thallus roseo-albidus, crassus, minute cancellatus chrysogonimicus. Apothecia tenella tota nigra, alt. ·7 mm., stipitibus gracilentibus crass. ·06 mm., capitulis lenticularibus lat. ·2 mm. Sporæ nigrescentes oblongæ aut oblongo-ellipsoideæ, long. ·005 mm. aut longiores, lat. ·002–·003 mm., apicibus rotundatis uniseptatæ.—Habitat ad Eucalyptos decorticatos putrescentes in Maffra, Gippsland.

Magna pars arboris visa est colore lichenis hujus roseo-albido tincta. Thallus contusus flavescit. Odore in mentem venit *Primula vulgaris*.

Fig. 20. Sporæ quatuor.

42. Calicium biloculare, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 21.)

Thallus albidus vel cinerascens tenuis. Apothecia tota nigra, alt. ·8–1 mm., stipitibus crass. ·1 mm., capitulis lentiformibus vel subturbinato-lentiformibus lat. ·3–·4 mm. Sporæ fuscescentes vel fusco-nigrescentes ellipsoideæ vel subfusiformi-ellipsoideæ, long ·005–·007 mm., lat. ·002–·003 mm., biloculares vel obsolete biloculares vel simplices, septo non viso, pariete nonnihil crasso.—Habitat ad Eucalyptos decorticatos putrescentes in Warrnambool.

Forsitan varietas *C. subtilis*, Pers.

Fig. 21. Sporæ quatuor.

43. Calicium capillare, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 22.)

Thallus albus tenuis vel tenuissimus. Apothecia tota nigra

gracilia, alt. 1 mm., stipitibus crass. 1 mm., capitulis turbinato-lentiformibus lat. ·3–·4 mm. Sporæ nigrescentes oblongæ vel ellipsoideæ, long. ·005 mm., lat. ·0025 mm., uniseptatæ.—Habitat ad Eucalyptos decorticatos putrescentes in Warburton et Mt. Macedon et Maffra.

Forsitan varietas *C. subtilis*, Pers.

Fig. 22. Sporæ duæ.

44. Calicium obovatum, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 23.)

Thallus cinerascens tenuis. Apothecia tota nigra, alt. ·8–1 mm., stipitibus gracilibus crass. ·08–·1 mm., capitulis obovoideis vel turbinatis lat. ·1–·3 mm. Sporæ nigrescentes ellipsoideæ, long. ·005–·012 mm., lat. ·003–·004 mm., uniseptatæ, duos loculos continentes, septis non semper visis.—Habitat ad lignum Eucalypti in Mt. Macedon. Forma capituli obovata hoc a Caliciis aliis dignotum.

Fig. 23. Sporæ tres.

45. Calicium piperatum, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 24.)

Thallus albido-cinerascens vel cinereus tenuis. Apothecia nigra minuta subsessilia, alt. ·2 mm., stipitibus crass. ·1 mm., capitulis lentiformibus discis planis lat. ·25 mm. Sporæ fusco-nigrescentes oblongæ, long. ·004–·008 mm., lat. ·0025–·005 mm., uniseptatæ, in quovis cellulo loculum globosum continentes.—Habitat ad Eucalyptos decorticatos putrescentes in Mt. Macedon.

Fig. 24. Sporæ tres.

46. Calicium nigrum, *Schaer.*, var. nov. minutum, *C. Knight.* (Pl. XLIX. fig. 25.)

Thallus obscure cinerascens granulosus. Apothecia tota nigra, alt. ·5 mm., stipitibus crass. ·1–·12 mm., capitulis turbinato-cylindraceis discis pruinosis lat. ·3–·7 mm. Sporæ nigrescentes ellipsoideæ, long. ·004–·012 mm., lat. ·002–·006 mm., uniseptatæ, in medio constrictæ loculum in utroque cellulo continentes.—Habitat ad lignum Eucalypti putrescens in Kew et Oakleigh.

Fig. 25. Sporæ duo.

47. Calicium bulbosum, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 26.)

Thallus albido-cinerascens. Apothecia stipitibus nigris fere

validis ad alt. 1 mm. et crass. ·2 mm. attingentibus, capitulis globosis, subtus cinereo-pruinosis, diam. ·5 mm. Sporæ fusco-nigrescentes subfusiformi-ellipsoideæ, long. ·006–·012 mm., lat. ·003–·005 mm., uniseptatæ, loculum in utroque cellulo continentes parietibus exterioribus distinctis rubescentibus.—Habitat ad Eucalyptos decorticatos putrescentes in Lakes Entrance, Gippsland.

Forsitan varietas *C. quercini*, Pers. An sit var. *subcinereum*, Nyl.?

Fig. 26. Sporæ tres.

48. Calicium curtum, *Turn. & Borr.*, var. minus, *F. Wils.*

Thallus albidus tenuis vel evanescens. Apothecia alt. 1·8 mm. sæpius minora, stipitibus crass. ·2 mm., capitulis turbinatis lat. ad 6 mm., infra albo suffusis. Massa sporali protrusa; sporæ long. ·005–·01 mm., lat. ·002–·003 mm.—Habitat ad Eucalyptos decorticatos putrescentes et supra trabes Eucalypti veteros. Frequens et in locis abundans. Raro apothecium majus invenitur.

49. Calicium trachelinum, *Ach.*, var. elattosporum, *F. Wils.*

Thallus obscure cinerascens vel albescens. Apothecia varia magnitudine ad 2 mm. alt. attingentia, stipitibus crass. ad basin ·25 mm., capitulis globosis vel turbinatis lat. ad ·5 mm. rufis ad marginem et stipitis superum etiam ad discum. Sporæ long. ·003–·008 mm., lat. ·002–·004 mm.—Habitat ad Eucalyptos decorticatos putrescentes. Species frequentissima in Victoria totius tribus et in locis abundans. Variat apotheciis validis; variat dein parvis; sæpe stipitibus longis et gracilibus. Aliquando in plagis multipedalibus occurrit apotheciis longis confertis adeo ut arbor videatur capillis brevibus vestitus. Sporæ varietatum omnium multo minus quam in descriptione Nylandri.

50. Calicium aurigerum, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 27.)

Thallus albus vel albidus crassiusculus. Apothecia parva, stipitibus nigris, alt. ·2–·8 mm., crass. ·05–·1 mm., capitulis omnino pulvere flavescente suffusis lentiformibus lat. ·4 mm. Sporæ nigrescentes vel fuscæ ellipsoideæ, long. ·005–·009 mm., lat. ·002–·004 mm., uniseptatæ, medio paullulo constrictæ in quovis cellulo loculum continentes.—Habitat ad Eucalyptorum ligna putrescentia in Mt. Macedon.

Fig. 27. Sporæ tres.

51. Calicium roscidum, *Floerke*, var. nov. Eucalypti, *F. Wils.* (Pl. XLIX. fig. 28.)

Thallus cinerascens tenuis, hic illic flavo-sorediosus et inde sterilis. Apothecia alt. ad 1·3 mm., stipitibus nigris crass. ·1 mm., capitulis turbinatis subtus plus minus flavo-virescentibus lat. ad ·3 mm. Sporæ fuscescentes vel plus minus dilute nigrescentes linea nigra definitæ ellipsoideæ utroque apice angustiores sæpe in medio constrictæ, uniseptatæ, long. ·005–·009 mm., lat. ·003–·005 mm., in utroque cellulo loculum continentes.—Habitat ad Eucalyptorum emortuum corticem et lignum in Mt. Macedon. Hæc varietas inter *C. roscidum*, Floerke, et *C. roscidulum*, Nyl.

Fig. 28. Sporæ duæ.

52. Calicium hyperellum, *Ach.*, var. validius, *C. Knight in Proc. Roy. Soc. Queensl.* vol. v. pt. 1.

Thallus sulphureo-cinerascens crassiusculus, verrucoso-inæqualis. Apothecia tota nigra, stipitibus brevibus et validis ad alt. ·5 mm. et crass. ·3 mm., capitulis turbinato-lentiformibus disco lecideiformi quasi margine proprio ad lat. ·5 mm. attingentibus. Sporæ fuscæ ellipsoideæ, utroque apice subacuminatæ in medio nonnihil constrictæ, long. ·007–·013 mm., lat. ·003–·006 mm., uniseptatæ.—Habitat ad lignum et truncos decorticatos putrescentes Eucalypti in Maffra, Gippsland. Interdum forma minor occurrit. Specimina Victoriana haud eis Queenslandiæ dignota sunt.

53. Calicium tricolor, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 29.)

Thallus sulphureus leproso-granulosus. Apothecia nigra parva, ad alt. ·75 mm., stipitibus ad crass. ·1 mm., capitulis turbinato-globosis lat. ·2–·5 mm., marginibus albo vittatis. Sporæ fuscæ fusiformi-ellipsoideæ, utroque apice subacuminatæ, long. ·008–·012 mm., lat. ·003–·005 mm., uniseptatæ, medio nonnihil constrictæ in utroque cellulo loculum fusco-nigrescentem continentes.—Habitat ad Eucalyptos emortuos decorticatos in Warrnambool et Metung, Gippsland. Simile apotheciis *C. curto*, Borr., sed sporarum distat forma et magnitudine et colore etenim thallo valde diversum.

Fig. 29. Sporæ duæ.

54. Calicium flavidum, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 30.)

Thallus flavidus vel sulphureus, crassus, lævis fere nitidus. Apothecia nigra, margine et aliquando deorsum a colore thallino colorata

robusta, ad alt. 1 mm. et crass. ·5 mm. attingentia, stipitibus breviusculis sursum crassescentibus, capitulis globoso-turbinatis. Massa sporali nigra protrusa. Sporæ fusco-nigrescentes ovoideæ vel subfusiformi-ellipsoideæ, long. ·006–·01 mm., lat. ·003–·004 mm., uniseptatæ, parietibus exterioribus rubescentibus cellulis fuscescentibus unum vel duo loculos nigrescentes continentibus.—Habitat ad lignum Eucalypti in Metung, Gippsland.

Fig. 30. Sporæ tres.

55. Coniocybe citriocephala, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 32.)

Thallus albus tenuis. Apothecia minuta, stipitibus gracilentibus nigris, alt. ad 1 mm., crass. ·06 mm., capitulis virescenti-flavidis turbinatis demum globosis diam. ad ·2 mm., massa sporali deposita, fuscis turbinatis. Sporæ incolores vel dilute flavidæ breviter oblongo-ellipsoideæ vel sphæroidales, long. ·032–·004 mm., lat. ·002–·003 mm.—Habitat ad arborum emortuorum ligna et cortices in Metung, Gippsland.

Fig. 32. Sporæ duæ.

56. Coniocybe ochrocephala, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 31.)

Thallus rufescenti-albidus (anne proprius?). Apothecia stipitibus fuscis tenellis, alt. ·6 mm., crass. ·06 mm., sæpe bifurcatis, capitulis globosis pallide ochraceis diam. ·25 mm. Sporæ incolores globosæ, diam. circa ·003 mm., loculum continentes.—Habitat ad *Asterem argyrophyllum* decorticatum putrescentem in Mt. Macedon.

Fig. 31. Spora.

57. Coniocybe rhodocephala, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 33.)

Thallus obscure virescens leprosus evanescens vel nullus. Apothecia majuscula, stipitibus fuscis vel pruinoso-nigris, alt. ad 2 mm., crass. ad ·2 mm., aliquando furcata vel duo pro parte coalescentia, capitulis globosis pallide roseis vel carneis raro albidis. Sporæ numerosissimæ conglomeratæ incolores ellipsoideæ vel oblongo-ellipsoideæ, long. ·003–·006 mm., lat. ·0015 mm., biloculares vel placodeinæ vel uniseptatæ, parietibus crassis. Paraphyses numerosæ discretæ.—Habitat ad corticem emortuum arborum putrescentium in Lakes Entrance, Gippsland. Unica

in hoc genere quoad sporarum formam elongatum et septatum.

Fig. 33. Sporæ quinque.

58. Trachylia lecanorina, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 34.)

Thallus cinerascens verruculoso-leprosus passim verrucoso-sorediatus, gonidia mediocria abundantia fovens. Apothecia parva, lat. ad ·5 mm., lecanoroidea conferta in receptaculis thallinis elevata. Massa sporali atra abundante sæpe valde protrusa et cum illa ex apotheciis vicinis conjuncta. Sporæ fusco-nigricantes vel nigrescentes vel fere incolores ellipsoideæ, long. ·01–·02 mm., lat. ·006–·01 mm., uniseptatæ.—Habitat ad repagula Eucalypti in Cheltenham et Streatham. Facie persimilis *Lecanoræ atræ.*

Fig. 34. Sporæ quatuor.

59. Trachylia viridilocularis, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 35.)

Thallus obscure cinerascens. Apothecia tota nigra nonnihil elevata, alt. ·3 mm., lat. ·3 mm. Massa sporali abundante. Sporæ nigricantes vel virescenti-nigricantes deformiter ellipsoideæ, long. ·01–·02 mm., lat. ·008–·01 mm., uniseptatæ, in quovis cellulo loculum sæpe virescentem unum rarius loculos duos continentes. Gonidia globosa vel ellipsoidea, diam. ·002–·01 mm.—Habitat ad repagula Eucalypti quadrati in Kew. Hic lichen cum *Calicio nigro* var. *minuto* conservatus est, *Trachylia* in repaguli facie perpendiculari, *Calicio* in facie horizontali putrescentiore.

Fig. 35. Sporæ quatuor.

60. Trachylia emergens, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 36.)

Thallus albus vel albidus tenuis lævis fere nitidus. Apothecia emergentia ut videtur e medio fibrarum ligni demum ægre super thallum exstantia, lat. ad ·5 mm. Massa sporali nigra. Sporæ fusco-nigricantes conglobatæ ellipsoideæ, circa ·005 mm. long. et ·003 mm. lat., sed multum variæ magnitudine uniseptatæ, in utroque cellulo loculum continentes. Gonidia oblongo-sphæroidea, diam. ·02 mm.—Habitat in repagulis Eucalypti in Mt. Macedon. Inventa quoque in Mt. Lofty, South Australia.

Fig. 36. Sporæ tres.

61. TRACHYLIA EXIGUA, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 37.)
Thallus cinerascens effusus. Apothecia parva aliquatenus in thallo depressa paullulum elevata disco plano vel convexo. Sporæ nigrescentes fusiformi-ellipsoideæ, circa ·008 mm. long. et ·003 mm. lat., uniseptatæ.—Habitat ad veteres repagulos Eucalypti in Mt. Macedon.

Fig. 37. Sporæ quatuor.

62. TRACHYLIA VICTORIANA, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 38.)
Thallus cinerascens tenuis effusus. Apothecia nigra typica sessilia sæpe brevissime stipitata, alt. ad ·4 mm., disco sæpius sulphureo pruinoso lat. ad ·4 mm. Sporæ fuscæ oblongo-ellipsoideæ, long. ·005–·006 mm., lat. ·003–·004 mm., uniseptatæ, in utroque cellulo loculum nigrescens continentes.—Habitat ad veteres repagulos Eucalypti in Oakleigh et Lilydale etc. frequens. Apothecia interdum sessilia et alias stipitata ægre decernuntur, sporis haud differentibus, utrum *Calicii* an *Trachyliæ* sint sporæ, tunica fusca mox detersa, fiunt nigricantes ellipsoideæ minores et apicibus angustiores, long. ·004–·005 mm.

Fig. 38. Sporæ tres.

Tribe SPHÆROPHOREI.

63. SPHÆROPHORON AUSTRALE, *Laur.*
Haud infrequens in Warburton et Black Spur.

64. SPHÆROPHORON AUSTRALE, *Laur.*, var. aut forma PROLIFERA, *F. Wils.*
Thallus cæruleo, pallidus convexus lævis, fere nitidiusculus, subtus albus, fossulato-canaliculatus vel scrobiculato-inæqualis, long. ad fere 3 poll., lat. 2–7 mm., subpinnatifidus, bis terve proliferus, ramulis linearibus varie divisis ornatus. Apothecia postica. Sporæ ut in typo.

Tribe BÆOMYCEI.

65. GOMPHILLUS BÆOMYCEOIDES, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 39.)
Thallus cinereus vel virescens effusus, aut tenuissimus, quasi illinitus, et nitidiusculus, aut aliquanto crassior, eroso-isidioso-granulatus. Apothecia biatorina, interdum hypothecio albo marginata, sparsa vel conglomerata depresso-globosa, diam. usque ad

1·5 mm., lævia rufo-fulvescentia juventute perpallida, ætate obscura et nonnihil deformata, subsessilia aut stipitata, stipitibus e constricto plus minus extenso hypothecio formatis validis usque ad ·5 mm. diam. et ·5 mm. alt., interdum uno stipite duobus vel tribus apotheciis coronato. Sporæ 8næ in thecis cylindricis aciculari-filiformes longissimæ, circa ·14 mm. septis numerosissimis divisæ. Paraphyses rectæ non discretæ. Spermatia minutissima.—Habitat ad arborum radices truncosque, supra muscos et corticem et Jungermannias et Lichenes, etenim supra terram et folia defuncta, etc., in sylvis umbrosis in Black Spur et Mt. Macedon et Warragul.

Thallus e filamentis varie dispositis conglutinatis constat, et gonidiis numerosis diam. circa ·01–·02 mm. arcte conglobatis. Apothecia texturæ corneæ tenacissimæ. Hypothecium album extra, intus pallido succineo fuscescens.

Dr. C. Knight (Nov. Zeyl.) speciminibus ab eo examinatis, cum scriptore sensit speciem esse novam et generis *Gomphilli*, ac nomen proposuit *bæomyceoidem*: at paucis tamen ab eo missis ad Prof. J. Mueller (Helvet.), hic lichenographus peritus speciem nominavit *Patellariam Wilsoni*: speciminibus *Gomphilli calicioidis* item a celeb. Massalongo ad Dr. Knight datis et ab hoc amice missis ad scriptorem studiose comparatis cum lichene novo, patescit hujus thallum esse illo similem sed crassiorem, gonidia similia sed aliquanto arctius conglobata et colore tristiora, elementa filamentosa persimilia, apothecia texturæ corneæ ipsissimæ sed majora, stipites similiter ex hypothecio formatas sed validiores et albidiores, capitula multo latiora et magis bæomyceoidea et colore alia, paraphyses subrectiores, hypothecium textura coloreque idem, potissimum sporas forma et longitudine et septis persimiles. Omnino est arcte affinis *G. calicioidi*.

Fig. 39. *a*. Sporæ duæ; *b*. Gonidia tria. Sporæ aliquanto rectiores quam visæ.

66. Bæomyces fusco-carneus, *F. Wils.*, sp. nov.

Thallus pallidus granuloso-verrucosus, granulis interdum depressis plagas parvas formans, 2–3 poll. Apothecia rufo-fuscescentia quasi pruinosa parva, lat. 1–2 mm., convexa, hypothecio marginata, stipitibus albis nudis brevibus vel breviusculis elevata, alt. minus quam 1 mm. Kal. thallus et apothecia flavi tunc sanguineo-rubri. Sporæ 8næ ellipsoideæ simplices, long. ·008–·01 mm., lat. ·003–·005 mm.—Habitat supra terram argillaceam in

Lilydale. Supra thallum et apothecia speciminis unici est lecidea parasitica.

67. Bæomyces heteromorphus, *Nyl.*

Frequens supra terram argillaceam in Mt. Macedon et Black Spur etc.

68. Bæomyces fungoides, *Ach.*

Frequens supra terram argillaceam in Mt. Macedon et Black Spur etc.

69. Thysanothecium hyalinum, *Berk. et Mont.*

Frequens supra ligna deusta in multis locis.

70. Philophoron conglomeratum, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 41.)

Thallus olivaceus (vigens viridis) haud limitatus isidioso granulatus. Podetia subcylindrica longitudinaliter costata vel lacunosa verrucoso-granulata passim isidiosa, long. 20 mm., crass. 1·5 mm., simplices vel in ramulos 2–4 apice divisa. Apothecia fusco-nigra conglomerata, diam. 4 mm. Sporæ ellipsoideo-fusiformes incolores simplices, long. ·01 mm., lat. ·003 mm. Hypothecium fuscum. Paraphyses discretæ conglutinatæ fuscescentes, apice fuscæ. Gel. hym. iodo intense cærulescens.—Habitat supra truncum arboris emortuum muscosum in Black Spur. Specimen unicum.

Fig. 41. Sporæ duæ.

71. Pycnothelia papillaria, *Duf.*

Haud infrequens super terram arenosam in Kew et Sandringham.

Neophyllis, *F. Wils.*, gen. nov.

(*Phyllis*, Linn., est genus Rubiacearum.)

72. Neophyllis melacarpa, *F. Wils.*, sp. nov. (Pl. XLIX. fig. 40.)

Thallus minutus, long. ·2–3 mm., lat. ·2 mm., cinereus (dum vigens viridis), subtus albus, laciniato-squamosus, squamis plerumque confertis imbricatis supra et infra convexiusculis confuse multifidis, laciniorum inferiorum apicibus crenato-divisis recurvis, laciniis ultimis plus minus teretibus. Apothecia cephaloidea atra sublævia et nitidiuscula subglobosa vel tuberculari-difformia, diam. plusquam 1 mm. attingentia, terminalia in laciniis thallinis

inferioribus podetia brevia anguste fistulosa constituentibus. Sporæ 8næ incolores ovato-ellipsoideæ, long. ·006–·008 mm., lat. ·004–·005 mm., simplices, sæpe 1–3 globulos continentes. Paraphyses non discretæ fuscescentes, apicibus fuscæ, crass. ·004–·005 mm. Spermatia minutissima, bacillaria uno apice incrassata. Gel. hym. iodo cærulescens.—Habitat supra truncos arborum permagnorum viventes atque putridos in regionibus montanis, Warburton et Mt. Macedon.

Squamæ thalli sæpius valde confertæ sunt, adeo ut solum apices teretes visæ sint, et inter hos semicondita globosa atra apothecia. Thallus e filamentis laxe intertextis simplicibus vel ramosis (crass. ·002–·005 mm.) constat, gonidiisque læte virentibus sphæricis vel oblongis (diam. ·005–·017 mm.) conglomeratis prope corticem thalli superiorem.

Affinis *Cladoniis* facie squamosa texturaque thalli et forma cephaloidina apotheciorum et forma coloreque sporarum; sed generice dignota thallo supra et infra convexiusculo, laciniis ultimis plus minus teretibus, et apotheciis terminalibus in laciniis thallinis inferioribus.

Fig. 40. Sporæ duæ.

EXPLANATION OF PLATE XLIX.

Lichen spores &c., magnified 1000 times.

Fig. 1. *Stigonema ephebeoides*; apex of thalline branch.
2. *Collema plumbeum*; spore.
3. *C. atrum*; 3 spores.
4. *C. congestum*; 4 spores.
5. *C. Senecionis*; 3 spores.
6. *C. quadriloculare*; 2 spores.
7. *Leptogium olivaceum*; spore.
8. *L. biloculare*; spore.
9. *L. Pecten*; 2 spores.
10. *L. Victorianum*; 2 spores.
11. *Obryzum myriopus*; spore.
12. *Myriangium dolichosporum*; 2 spores.
13. *Calicium jejunum*; 2 spores.
14. *C. niveum*; 2 spores.
15. *C. Victoriæ*; 2 spores.
16. *C. parvulum*; 2 spores.
17. *C. contortum*; 2 spores.
18. *C. gracillimum*; 3 spores.
19. *C. deforme*; 4 spores.
20. *C. roseo-albidum*; 4 spores.
21. *C. biloculare*; 4 spores.

Fig. 22. *Calicium capillare*; 2 spores.
23. *C. obovatum*; 3 spores.
24. *C. piperatum*; 3 spores.
25. *C. nigrum*, var. *minutum*; 2 spores.
26. *C. bulbosum*; 3 spores.
27. *C. aurigerum*; 3 spores.
28. *C. roscidum*, var. *Eucalypti*; 2 spores.
29. *C. tricolor*; 2 spores.
30. *C. flavidum*; 3 spores.
31. *Coniocybe ochrocephala*; 1 spore.
32. *C. citriocephala*; 3 spores.
33. *C. rhodocephala*; 5 spores.
34. *Trachylia lecanorina*; 4 spores.
35. *T. viridilocularis*; 4 spores.
36. *T. emergens*; 3 spores.
37. *T. exigua*; 4 spores.
38. *T. Victoriana*; 3 spores.
39. *Gomphillus bæomyceoides*; *a*. 2 spores; *b*. 3 gonidia.
40. *Neophyllis melacarpa*; 2 spores.
41. *Philophoron conglomeratum*; 2 spores.

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Attention to this announcement is specially requested, to prevent application to the Librarian for unpublished Parts.

The first Meeting of the Session 1891–92 will be held on Thursday, Nov. 5, and the ensuing Meetings for the present year will take place on Nov. 19, Dec. 3, and Dec. 17, when the Chair will be taken at 8 P.M.

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VOL. XXVIII. **BOTANY.** No. 196.

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The Effect of Exposure on the Relative Length and Breadth of Leaves. By G. F. Scott Elliot, M.A., B.Sc., F.L.S.

[Read 18th December, 1890.]

The effect of sunlight on the absolute size of leaves is known, from the magnificent researches of Stahl, to consist chiefly in a reduction of the leaf-surface. The works of Volkens, Tschirch, Schenck, and others have proved that this reduction of the surface is a common characteristic of those plants which are more particularly exposed to strong sunlight, *e.g.* desert plants and plants living on dry sea-sand.

It is also well known that along with this reduction in surface there is usually an increase in thickness of the leaf—that is to say, in the same species when grown under specially exposed conditions.

No one who has read the evidence on the subject can, I think, doubt that this tendency to reduce the amount of leaf-surface, and at the same time increase its thickness, is connected with the greater transpiration in more exposed habitats, and that the effect of sunlight is (at least to a great extent) indirect and produced by its favouring transpiration.

It is also generally recognized that shade-plants tend to have longer internodes than those which are exposed to sun and wind (Wiesner, *e. g.*, has shown that the dandelion, when grown in moist still air, forms internodes); and this "drawn" character of plants grown in shady or sheltered spots is quite familiar to open-air botanists, and one can scarcely doubt that it also is connected with the transpiration being less in such places than it is in exposed ground.

If one assumes these facts, viz. that exposure in a general sense (to wind and sun) contracts the internodes and produces a diminution in the absolute length and breadth of the leaves as well as a transverse thickening, then one would expect that the relative length and breadth would also be changed, so that in exposed plants the leaves would, in most cases, become broader proportionately. There is some reason for the above assumptions, as I do not think any one who has collected plants in hot countries can have failed to notice these tendencies, and, moreover, the literature of the subject is very large and remarkably harmonious.

The following observations give some direct proof that this is really the case. Those made by me consist partly of a series of measurements made in Madagascar, and partly of the results given by an experimental garden, which I have had made this summer at home. I found on my return that Sorauer (in a paper published in Wollny's 'Forschungen') had anticipated my conclusions, and his results, as well as such other more indirect observations as I have been able to bring to bear on the point, confirm my own measurements. The first series of observations were made on the leaf-blade of grasses. In every case two sets of plants were gathered: the first (form A throughout the experiments) were taken from shady places, or had been sheltered during their growth by bushes or other plants, or were more thickly grown. The second (form B) were taken from the most exposed and driest spots I could find. The first Table shows the measurements which I made on a species of *Agrostis*, which turned out to be new (*A. Elliotii*, Hack. in Journ. Linn. Soc., Bot. vol. xxix. p. 65). These were preliminary and chiefly for the purpose of seeing how far the different leaves on the same stem (counting from below upwards) varied in this respect.

TABLE I.

Leaf-proportion in *Agrostis Elliotii*, Hack.

	Length of leaf.	Breadth of leaf.	Leaf-ratio.
Second leaf (from base), A	16·6	·36	4·611
Second leaf (from base), B	9·75	·32	3·047
Third leaf (from base), A	16·9	·55	3·073
Third leaf (from base), B........	9·8	·33	2·97
Fourth leaf (from base), A	13·9	·63	2·206
Fourth leaf (from base), B	7·1	·34	2·09

They show that the relative length varies greatly, and that the lowest leaves, which are, of course, most protected from wind and sun, are the longest proportionately. In all the following

cases I took care to keep to the lower and mature (though not withered) leaves, and I usually measured at least one hundred leaves of each form. The measurements are expressed in decimals of an inch. The last column is the calculated decimal value of the length divided by the breadth, which I have called the leaf-ratio. I have found this ratio of the greatest use in studying the effect of exposure.

Table II. shows the result of the whole set of observations made on grass-leaves.

TABLE II.

Leaf-proportion in Grasses.

		Length of leaf.	Breadth of leaf.	Leaf-ratio.	Number of leaves measured.
Stenotaphrum glabrum.	Form A	7·9	·5	15·8	68
" "	Form B	1·82	·3	6·07	60
Paspalum distichum, L.	Form A	2·3	·1	23	60
" "	Form B	1·1	·1	11	60
Cynodon Dactylon, Pers.	Form A	·73	·1	7·3	100
" "	Form B	·45	·1	4·5	60
Eragrostis ciliaris, Link.	Form A	3·24	·1	32·4	53
" "	Form B	2·8	·16	17·5	38
Cenchrus echinatus, L.	Form A	8·32	·37	22·5	60
" "	Form B	4·55	·23	19·8	90
Centotheca mucronata, Hack. ……		2·89	·43	6·7	80
Centotheca madagascariensis, Hack.		5·4	·47	11·5	100
Thuarea sarmentosa, Pers. ………		·81	·3	2·7	100
Eragrostis plumosa, Link …………		1·94	·13	15	100

It is seen that there is no exception in the first five cases to the rule that in Form A, which is that from sheltered ground, the leaf-ratio is the greatest, or the leaves are relatively longer. The two *Centothecas* are very interesting, as I took them to be the same species, and the second (*C. madagascariensis*), corresponding to Form A, was from more sheltered places than the other. This tends to show how specific differences may arise (see *infrà*). *Thuarea* is a prostrate grass which grows in sandy soil, and contrasts strongly with *Eragrostis plumosa*, which is an upright shade-form. The next series were made from such plants as I could collect in a short distance from my house, as I was disabled through fever and other ailments from walking far at the time. (Table III.)

It is seen that in the whole set of fifteen species there are

only two cases where the shade-form has relatively broader leaves than the sun-form. In *Psiadia* this difference is perceptible, but in the other case, *Lycium*, the difference is only that between 1·93 and 1·92. Three other cases show a scarcely measurable difference, but, on the whole, the relatively longer and narrower

TABLE III.

Leaf-proportion in various Plants.

		Number of leaves measured.	Length of leaf.	Breadth of leaf.	Leaf-ratio.
Microrhynchus sarmentosus ...	A	100	4·04	·59	6·85
" " ...	B	100	1·5	·32	4·69
Lobelia Scævola..................	A	100	7·73	3·49	2·22
" "	B	100	3·27	2·1	1·56
Psiadia dodonæfolia	A	100	3·89	·38	10·21
" "	B	100	1·82	·16	11·38
Helichrysum emirnense.......	A	100	·94	·1	9·4
" "	B	100	·45	·08	5·63
Spermacoce globosa	A	100	1·27	·21	6·04
" "	B	100	·68	·16	4·25
Lycium capense, Mill.	A	100	·73	·38	1·92
" "	B	100	·52	·27	1·93
Brexia madagascariensis	A	50	4·55	2·55	1·76
" "	B	50	3·27	2·12	1·54
Camptocarpus, sp.............	A	100	1·24	·3	4·13
"	B	100	1·21	·34	3·56
Periploca ovata, Decne. ...	A	100	1·17	·73	1·6
" "	B	100	·92	·62	1·49
Commelina nodiflora............	A	100	2·24	·69	3·25
" "	B	100	1·23	·42	2·93
Tanghinia venenifera	A	100	7·29	1·54	4·74
" "	B	100	5·36	1·5	3·57
Brachystephanus cuspidatus...	A	30	4·31	2·56	1·7
" " ...	B	50	2·46	1·45	1·7
Monimia, sp.	A	50	2·93	1·47	1·99
"	B	50	2·47	1·37	1·8
Sida carpinifolia	A	100	2·75	1·07	2·57
" "	B	50	1·65	·76	2·17
Vinca rosea	A	50	2·49	1·09	2·28
" "	B	50	1·89	·83	2·28

form of the shade-leaves is very obvious; the average difference in the leaf-ratio in favour of the shade-leaves taken from the whole fifteen cases being as much as ·62.

The leaves of climbing and prostrate plants (at least those which are petiolate) show another peculiarity, which comes out clearly in Table IV. It consists in the leaves of those fully

exposed to the sun being actually, as well as relatively, broader. The last case, *Ipomœa Pescapræ,* is interesting, as the Forms 1 and 2 were taken from the same plant. Those in Form 1 were gathered from the upright stems, seldom eighteen inches high, springing from the main root, while those in Form 2 were from the prostrate branches of the same plant, which are sometimes seventy feet long.

TABLE IV.

Climbing-plants with petiolate leaves.

	Length of leaf.	Breadth of leaf.	Leaf-ratio.
Mikania scandens. A..........	1·533	1·173	1·31
,, ,, B..........	1·029	1·217	·85
Ipomœa palmata. A.	1·408	1·42	·99
,, ,, B.	1·462	1·486	·98
Ipomœa Pescapræ (1)	3·223	3·16	1·02
,, ,, (2)	2·41	4	·6

The difference in this last case is not due to exposure, but was produced by the greater development of the basal veins of the leaf in Form 2. I find Sir John Lubbock has pointed out a similar difference in the leaf of the ivy. It seems to me possible that this is due to the angle at which the blade is inclined to the petiole; and one finds, I think, pretty generally that when there is a distinct and abrupt angle between the petiole and midrib, the leaf tends to become cordate, peltate, or generally broad towards the base. In this case and the ivy the leaves on the upright stems, which are narrower, have the petiole and midrib almost in a straight line. On this point, however, I have not finished my experiments. Such relatively broad leaves are common in climbing and prostrate plants; and if this angle of petiole and midrib does affect the form of the leaf, it may perhaps modify the effect of sheltered conditions. Still, in the three cases given the rule is followed.

The general result of these experiments is confirmed by Dufour. His experiments (Ann. Sci. Nat., Bot. sér. 7, t. v

1887, p. 339) were an attempt to show that sunlight increased the size of the leaf. In the course of them he took measurements of the leaves of two sun-flowers, of which one was planted in the shade and the other in the sun.

He did not, however, see any importance in the relation of length to breadth, and I have calculated the ratios in the third column of the following Table (V.).

Table V.

Dufour's experiments.

	Length in mm.	Breadth in mm.	Leaf-ratio.
4th leaf, sun	86	24	3·58
" shade	66	18	3·67
5th leaf, sun	92	25	3·68
" shade	40	11	3·64
6th leaf, sun	102	25	4·08
" shade	34	9	3·78
7th leaf, sun	113	25	4·52
" shade	34	8	4·25
8th leaf, sun	121	31	3·9
" shade	47	11	4·27
9th leaf, sun	140	38	3·68
" shade	58	14	4·14
General averages sun-leaves	109	28	3·9
Do., shade-leaves	46·5	11·8	3·95

The slight confirmation is the more valuable, as Dufour had no idea of this relative difference.

Sorauer, in a paper published in Wollny's 'Forschungen,' Bd. ix., gives a number of tables which show exactly the same thing. In this paper he also points out clearly that in plants growing in wet air the leaves become longer relatively as well as actually. In the Botan. Zeit. 1878, p. 1, a few more measurements are given by Sorauer, from which I extract the following, and have calculated the ratios:—

Plants of dry air (average from five plants) gave for length of leaf 21·89 cm., for breadth 6·46 cm, or a ratio of 3·39. Similar plants grown in wet air gave for length 22·39, breadth 5·81, or a ratio of 3·85. Another set gave:—*for dry air* (average of nine plants), length 17·7, breadth 7·33, or a ratio of 2·41; *for wet air* (average of eight plants), length 17·9, breadth 6·74, *i.e.* a

ratio of 2·65. Both show a greater ratio for the plants grown in wet air. Both Dufour and Sorauer measured the lengths of but very few leaves. Those in Dufour's experiments, *e.g.*, are the actual lengths and breadths of individual leaves. My own results are all averages, and it is, I think, easier in this way to get rid of individual variations.

MM. Vesque and Viet also give a few measurements from their culture experiments.

When the plants (spinach) were grown in lines 25 cm. apart, the ratio $\frac{\text{length}}{\text{breadth}}$ equalled $\frac{33 \text{ cm.}}{16 \text{ cm.}}$, or 2·063.

When entirely isolated this was $\frac{46 \text{ cm.}}{24 \text{ cm.}}$, or a ratio of 1·92. This shows exactly the same influence.

Wiesner, in his 'Biologie d. Pflanzen,' pt. iii. p. 51, has also figured a very striking case of extraordinary elongation due to growth in humid conditions, and caused, as he suggests, by the greater "*ductility*" of the leaf under these circumstances.

Costantin (Ann. Sci. Nat., Bot. sér. 7, vol. iii. 1886) also speaks of "*un allongement exagéré parallèlement aux nervures*" in plants grown in humid conditions (*milieu aquatique*).

This summer I had a small experimental garden formed for the purpose of trying the effect of different soils on the growth of annuals. The garden consisted of five beds, only one foot apart from one another, and consisting respectively of:—

1st. Peat (2½ feet deep).
2nd. Calcareous sand and loam.
3rd. Pure sand.
4th. Leaf-mould and sandy loam.
5th. Manure and sandy loam.

The plants were sown across all these beds.

The following Table (p. 382) shows the result of the measurements of the leaves, 100 from each bed having been measured in almost every case.

These results show that the leaf-ratio, instead of being in the order of the actual length of the leaves, that is, shortest in the peat and gradually longer in sand, lime, manure, and leaf-mould respectively, follows almost exactly the reverse order, being highest in the case of the sand-plants, and lowest in those of the manure. The heights of the plants in the various beds were in the same order as their length of leaf; that is, the peat-plants

TABLE VI.

	Peat-bed.			Sand-bed.			Lime-bed.			Manure.			Leaf-mould bed.		
	Length of leaf.	Breadth of leaf.	Leaf-ratio.	Length of leaf.	Breadth of leaf.	Leaf-ratio.	Length of leaf.	Breadth of leaf.	Leaf-ratio.	Length of leaf.	Breadth of leaf.	Leaf-ratio.	Length of leaf.	Breadth of leaf.	Leaf-ratio.
Tropæolum majus ..	·65	·73	·89	2·4	1·3	1·85	1·45	1·51	·96	2·52	2·54	1	2·08	2·14	·97
Lupinus subcarnosus	1·88	·55	3·42	2·41	·7	3·44	2·55	·74	3·44	3·04	·85	3·58	3·27	·93	3·52
Candytuft	1·01	·21	4·81	2·36	·45	5·24	2·2	·33	6·67	2·27	·38	6	2·49	·49	5·08
Mathiola bicornis ...	1·11	·17	6·53	3·25	·53	6·13	3·9	·63	6·19	4·2	·68	6·18	4·02	·65	6·18
Saponaria calabrica	1·17	·34	3·44	1·73	·46	3·76	1·4	·7	2	1·68	·51	3·3	2·17	·57	3·82
Convolvulus tricolor .	·92	·31	2·97	1·24	·48	2·58	2·32	·78	3	3·28	1·29	2·54	3·09	1·39	2·22
Linum rubrum	·4	·09	4·44	·76	·19	4	·73	·18	4·06	1·06	·26	4·08	1·69	·51	3·31
General average, lengths	1·02	......	......	2·02	......	......	2·08	......	......	2·58	......	......	2·69		
General average, breadths...........	......	·34	......	......	·59	......	......	·69	......	......	·93	......	......	·95	
General average, ratios	......	......	30·6	......	......	34·24	......	......	30·1	......	......	27·7	......	......	28·32

were shortest, the sand next, then the lime, then the manure, and the leaf-mould plants were the highest. Almost exactly the same order was observed in the amount of branching per plant, in the number of flowers per plant, and in the average horizontal space and depth to which the roots extended. A full account will be found in the 'Gardener's Chronicle' (Dec. 6, 1890, and the following number).

The result is perhaps explained by the fact that, excepting peat, which is a positively injurious soil, the amount of water in the soil is probably most in leaf-mould and manure, less in lime, and less again in sand. Hence transpiration will be most active in the case of leaf-mould, less in manure, still more so in lime, and least in peat and sand.

It is doubtful, however, whether this conclusion is warranted.

Still, even if we exclude the case of these experimental beds as indecisive, we can, I think, consider that the main conclusion I have drawn is pretty safe. Sorauer's, Dufour's, Wiesner's, and my own measurements show that plants grown in sheltered situations have more drawn-out leaves, just as they have longer and thinner stems.

This is an important point in systematic character, as a lanceolate, linear, or ovate leaf simply arises from the different proportions between length and breadth. If, then, climate or exposure can, as I think I have shown, produce variations in this respect on which natural selection may afterwards begin to act, we can see how a new species may be formed.

The difference between *Ranunculus reptans* and *R. Flammula*, for instance, is chiefly a difference in the leaf-ratio, the leaves are longer and narrower in the second form; and Ross has experimentally changed the one into the other by growing them under different conditions, and, so far as I can gather from his paper, his method consisted in increasing the amount of moisture.

The cause of this change is not explicable without a somewhat rash and speculative expression of views. There is, however, no doubt that the effect of exposure or accelerated transpiration is to increase the toughness and rigidity of the leaf and especially to thicken the epidermis. This follows from the culture experiments of Costantin, Dufour, Sorauer, Wiesner, &c. The comparative researches of Von Höhnel, Klausch, Schenck, Noack, Wiesner, and Grevillius show that in nature a greater toughness is produced in the same species by greater exposure.

Extremely thick epidermis, moreover, characterizes species which are naturally found in particularly exposed habitats (compare Volkens, Schwendener, Tschirch, Giltay, Heinricher, Fleischer, Johow, and Schimper).

Now it seems to me that what is called in Germany "the inner causes of growth" may, without wild speculation, be looked upon as an actual force within the leaf, which tends to elongate it in a direction parallel to the midrib. At any rate, they may be supposed to act in this way.

Now if, as is really proved, the epidermis becomes tougher in an exposed habitat, it seems natural enough that the greater resistance to this elongating force would make the leaf tend to become broader proportionately, as well as thicker (*cf.* Hoffman and Scholtz).

This force, however, has not been *proved* to exist.

It struck me as being an interesting point to see whether the petals are also influenced by exposure and tend to become longer and narrower when grown in sheltered places.

I therefore made a series of measurements on the length of the corolla-tube in *Vinca rosea*.

One set (Form A) were taken from plants sheltered by grass and other plants. The others (Form B) from particularly exposed specimens.

I found:—

Average length corolla-tube in A ...... ·982
" " " B ...... ·943

So that the difference is not marked enough to judge from.

The effect of the soil is, however, much more easily visible.

Thus, in the experimental garden before alluded to, I measured in *Tropæolum* the length along the spur from the tip of the sepal to the tip of the spur, and the lengths and breadths of the anterior petal. I found:—

	Peat.	Manure.	Sand.	Lime.	Mould.
Length of spur	1·522	1·875	1·964	1·975	2·182
Length anterior petal	1·05	1·375	1·463	1·359	1·5
Breadth anterior petal......	?	·725	·9	·89	·92
Ratio (approximate).........	?	1·9	1·6	1·5	1·6

These differences, though they also show a distinctly larger flower in the leaf-mould, are too small to be of much practical importance.

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On Variations in the Floral Symmetry of certain Plants having Irregular Corollas. By W. BATESON, Fellow of St. John's College, Cambridge, lately Balfour Student, and ANNA BATESON. (Communicated by FRANCIS DARWIN, M.B., F.R.S., F.L.S.)

[Read 2nd April, 1891.]

(PLATES L. & LI.)

INTRODUCTION.

THE following observations, which we propose to extend, are put forward as a contribution to a study of the nature of the variations by which irregular forms of corollas are, or may be, produced. As to the causes which have operated in the production of these variations, we offer no suggestion: until a much fuller knowledge of the modes of Variation shall have been attained, discussion of the causes of Variation, or even curiosity concerning them is, in our judgment, premature.

As a problem in Evolution, the nature of the changes by which irregular corollas come into existence is especially interesting. It is, of course, well known that there is in the case of many irregular flowers strong evidence that their peculiar forms are adapted to the process of cross-fertilization by particular insects, or otherwise. From this evidence it is naturally expected that the same is true generally for irregular corollas. This conclusion leads in turn to the deduction that the evolution of the forms of irregular corollas, as we know them, has occurred in connexion with their adaptation to the purposes of cross-fertilization, and that their perfection and persistence have consequently been achieved by the agency of Natural Selection.

As to the exact steps by which such a process may have occurred, we have no knowledge or even plausible surmise. All that we can affect to know is that each form, like other forms of living things, is a term in a series of Variations, but as to the nature and magnitude of the integral steps between successive terms there is no direct evidence. Nevertheless, to obtain such evidence is absolutely necessary before any successful attempt to get an insight into the working of Evolution can be made. If

the results that we see have come about by the occurrence of a series of Variations, it is of the first importance to know what kind of series is constituted by these varying forms, and on the answer to this question all advance in the study of Evolution depends. In the absence of some knowledge of the mode in which variations occur, it is useless to guess at the relationships or past descent of existing forms; while conjecture as to the developments which may in the future be possible to these forms is still more hopeless.

The first question, then, to be answered is this: If we had before us the whole series of individuals which have occurred in the line of descent of one given form, what *kind* of series would these individuals compose? It is too much to expect that we should discover what the series has actually been, for the evidence is gone; but we may reasonably hope to find out what are the general characteristics of such a series, for the series itself is still in progress. It is nevertheless a remarkable circumstance that a great deal of enterprise and research has of late been given up to the object of ascertaining what the actual pedigree of divers forms has been, while no one has yet succeeded in the preliminary task of determining any of the general characters of such a series. Yet if the modern conception of the manner of origin of new forms is a right one, it is a process now at this time occurring, which by common observations we may now see. Surely such observations may become the foundation of a solid and reasonable knowledge of the attributes of the method of Evolution; and when such a base shall have been established, it may perhaps be safe to attack the special problems of descent.

Supposing, then, that such a series of ancestors were before us, the matter to be determined would be the degree to which the series is continuous or discontinuous: that is to say, whether the differences between any one member and its immediate successor are so small as to be imperceptible, or whether there are distinct and palpable differences between them; or whether they are sometimes small, and sometimes so great as to cause interruptions in the series and to divide it into groups of which the composing members are similar, though the successive groups are unlike each other.

The success of any attempt to comprehend the nature of the

forces which are at work in the production of Variation will depend very largely on the precision with which we shall be able to answer these questions, and to determine the degree of continuity which is present in the process of Evolution. For if, on the one hand, the transition from form to form shall be found to occur by insensible and minimal changes which are so small that no integral change can ever be perceived, we should recognize an analogy with the continuous action of mechanical forces; but if it should appear that the series is a discontinuous one, and that there are in it lacunæ which are filled by no intermediate form, the analogy would rather hold with the phenomena of chemical action, which is known to us as a discontinuous process, leading to the formation of a discontinuous series of bodies, and depending essentially on the discontinuity of the properties of the elementary bodies themselves.

It may be observed at this stage that in proportion as the process of Evolution shall be found to be discontinuous the necessity for supposing each structure to have been gradually modelled under the influence of Natural Selection is lessened, and a way is suggested by which it may be found possible to escape from one cardinal difficulty in the comprehension of Evolution by Natural Selection.

For there is one obvious consideration which makes it difficult to suppose *both* that the process of Variation has been a continuous one, and also that Natural Selection has been the chief agent in building up the mechanisms of living things. This difficulty, which is well known, may be stated thus. If the process of Variation is supposed to have been continuous, it cannot be supposed that the mechanism was at all periods of its evolution so beneficial as to be selected. For, from our knowledge of Natural History, we are led to think that while certain devices and structures may be beneficial to their possessors, yet they are so only by reason of the degree of perfection in which they exist; and that if they were materially less perfect, their utility would cease. Besides, even if there had been at some phases in their state of imperfection other functions for which they were adapted, yet still in any process of continuous evolution there must be substantially many transitional forms which are useful for no purpose, and therefore cannot be selected: in short, that the evolution of a special contrivance for adaptation is not com-

patible with constant and perpetual usefulness. It is clear that the degree to which this difficulty applies to any case is proportional to the complexity, perfection, and singularity of the contrivance.

In addition to the foregoing objection, a further difficulty arises when we try to figure to ourselves the kind of transitional stages by which the evolution of a complex mechanism may have been brought about. We are here met by an entire want of evidence as to the nature of such changes, and it is not easy even to conceive any hypothetical plan on which they may have occurred.

On the other hand, the objections to supposing that the process of evolution of such forms is *discontinuous* are derived, firstly, from the scarcity of observed instances of sudden and large variations, while small variations are familiar. Secondly, there is a presentiment, which is intuitive in the minds of some, that the processes of Nature are continuous processes, and that an appearance of discontinuity is due to imperfect knowledge of these processes. With the latter difficulty we are not concerned; but it is in the hope of dispelling the former objection that the present observations are recorded.

It may be remarked that large and sudden variations have not unfrequently been observed in organs repeated in a regular series, as the petals of regular flowers, &c.; but such changes, though considerable, commonly affect all these organs equally and in such a way that the original regularity remains in the modified structure. The significance of the following examples, however, lies in the fact that they not only show the facility with which irregular systems may be converted into regular ones, but that some of them are also instances of *irregular but symmetrical* systems formed afresh, apparently as sudden variations. It will be seen that in some of these cases the resulting symmetries, though irregular, are to all appearances as perfect as those of the normal flowers.

Whether the mechanisms of the flowers thus occurring as sudden variations are useful mechanisms, and whether they are or are not adapted for cross-fertilization by some particular insect, we are unable to say.

I. Linaria spuria.

This plant, together with *L. Elatine*, is very common in both barley and wheat stubbles on heavy land round Cambridge, though almost, if not quite, absent from lighter soil. In the course of examination of a very large number of specimens of *L. Elatine*, not a single abnormal flower was found; while in the case of *L. spuria* a great proportion of plants bear abnormal flowers. The figures at our disposal do not justify an accurate statement as to the percentage of plants bearing flowers of other than normal form, but we are well within the mark in saying that these are not less than thirty per cent. of the whole number of individuals.

The area examined is bounded by the Ely road on the one side and the Madingley road on the other, extending for about four miles from Cambridge. It contains a great number of stubbles, and *L. spuria* and *L. Elatine* are very common in nearly all. The proportion of abnormal flowers was about the same in all parts of the area investigated; but in the case of a single locality lying in the parish of Landbeach (outside the area defined above) no abnormal flower was found. All the specimens in this place were of unusual habit, having erect stems, some 10 inches in height, in addition to the usual procumbent stems. Upon these plants no abnormal flowers were found; and, speaking generally, the plants in other localities which had erect stems bore normal flowers only. Specimens of this description were not common in the district. Besides the erect position of the stem, these plants also are remarkable for the peculiar pale green colour and flannel-like texture of the leaves.

Normal Flower. (Plate L. figs. 1 & 2.)

A normal corolla of *L. spuria* is pentamerous and bilabiate, being composed of two posterior petals and three anterior ones. The two posterior petals are of a dark-purple colour on the inside, while the anterior petals are primrose-colour in their free portions, shading to a darker tint towards the interior of the flower; the slight inflations which occur at the points of union of the lower petals are also orange-yellow. Between the posterior petals and the anterior ones there is on either side a

deep cleft which divides the two lips from each other. The sepals are five in number and are regular in size and arrangement, one being placed centrally in the upper limb of the flower. The stamens are four in number and stand opposite the lateral sepals. The two anterior stamens are a good deal longer than the posterior pair. The filaments of all the stamens bear hairs, but the hairs of the anterior pair are considerably longer than those of the posterior pair. Until dehiscence the anthers cohere. The stamen which should stand opposite the posterior sepal, if the symmetry were regular, is represented only by a filament of reduced length, and bears no anther. The pistil stands in the centre of the ring of stamens. The anterior limb of the corolla is continued into a single, hollow, curved spur. For purpose of comparison with flowers having more than one spur, it should be noted that this single spur is formed from the tissues of the median anterior petal.

ABNORMAL FLOWERS.

Peloric. (Plate L. figs. 8–15).—As will be seen, there is great diversity of type among the abnormal flowers. The form which is perhaps more common than any other, except the normal, is of the well-known *peloric* type. In this form of flower the corolla is regular and tubular, having a general resemblance to a flower of the Cowslip. The corolla has five spurs instead of one; but in many cases these spurs do not all project from the tube, but some or all of them may be invaginated into it. This invagination may be complete or partial. In these peloric flowers the fifth stamen is always developed and bears an anther. The five stamens are of equal length, and the hairs on all of them are similar. The anthers are coherent above the stigma.

The petals of peloric flowers are generally yellow, being irregularly blotched with purple, but a few were found which were uniformly pale purple and many were seen which were entirely yellow. Peloric flowers having 6 sepals, 6 petals, and 6 stamens are not rare: in all of these the number 6 occurred in the stamens as well as in the corolla.

A few flowers were found having five similar yellow petals, which were not united posteriorly to form a tube, but were arranged as a single anterior lip.

An attempt was made to see whether these peloric flowers generally set seed or not, but the result was not very reliable,

owing to the doubtful character of the evidence *. The corollas fall off as the seed-vessel enlarges, and it is then not possible to determine upon what type the flower was formed, while, on the other hand, persistence of the corolla is generally associated with atrophy of the seed-vessel. An examination of flowers which still bore the withered corolla showed that a large proportion even of normal flowers set no seed; but in several instances the seed-vessel had enlarged, and there was every appearance that the seed was sound. Out of a large number of withered peloric flowers examined, an enlarging seed-vessel containing healthy-looking seed was only found in one case; but from the ambiguity of the evidence it cannot safely be inferred that very few peloric flowers set their seed, for some of those seed-vessels which have enlarged and lost their corollas may have borne peloric flowers. On the whole the impression was produced that comparatively few peloric flowers set seed. The peloric form is well known in *Linaria vulgaris*, &c.

We shall now describe other abnormal forms in which the corolla is still irregular, though its symmetry differs from that of the normal flower. Of such abnormal flowers five forms were seen which were symmetrical, and in addition to these some of more or less asymmetrical shapes were found.

No. 1. *Flower having the corolla shaped as in the normal form, but possessing two spurs instead of one* (Plate L. fig. 3).—Such flowers are not very common, but can generally be obtained by searching. In all those examined, the central posterior stamen (which is aborted in normal flowers) was fully developed.

Before comparing the spurs of this abnormal form with that of the normal flower, it may be remarked that the spur is of course developed from the base of a petal and not from the tissue lying between two petals. Since, then, in the normal flower the spur is an outgrowth from the base of the middle anterior petal, it is clear that if two spurs are developed and one of them is that of the median petal, the other must be formed from a lateral petal, and therefore be in origin asymmetrical.

* There is of course no question that such peloric forms set seed sometimes, but we wished to know whether they did so as often as normal flowers. Darwin, for example, raised seedlings of peloric *Antirrhinum* ('Animals and Plants,' 1885, ii. p. 71); and Willdenow (Species Plant. iii. 254) gives evidence showing that the same is almost certainly true for *Linaria vulgaris*.

Nevertheless, in the case of flowers presenting this modification, it was often found that the tissues were so bent from their original position that the division between the two spurs came to lie in or near the median plane of symmetry of the flower. To such a degree did this occur, that it was only by tracing up the bundles in the walls of the spurs that it could be determined from which petal they were developed. In several cases, however, the original symmetry was still shown by their position.

No. 2. *Flower having one posterior (purple) petal and four anterior (yellow) petals* (Plate L. figs. 5 & 6).—This form is very common throughout our region, and occurs on a large proportion of the plants, though perhaps not quite so commonly as the peloric type. Such flowers were never seen with less than two spurs, but occasionally they have three (Plate L. fig. 6). In all cases examined, the five stamens were all developed.

The calyx of these flowers was placed in such a position that the median vertical plane of the flower fell between two posterior sepals. Hence, though we are not able to state what the relations to the floral axis have been developmentally, yet the appearances decidedly suggest that this flower may be compared with the normal flower by imagining that *the median plane of the zygomorphy has been deflected so that it falls upon a posterior petal instead of on an anterior one.* What the circumstances may be which lead to this alteration of the plane about which the symmetry of the flower is formed, we can offer no suggestion, but we shall offer another case of a similar phenomenon in describing the variations of *Gladiolus* (*vide* p. 400).

Fig. 4 represents a flower which is in a manner intermediate between Nos. 1 and 2. For in it one of the posterior petals is partially coloured yellow, and is to some extent united to the adjacent petal of the anterior lip. Cases of this kind, in which a petal does not stand truly with either the anterior or posterior lip, are decidedly uncommon. Such intermediate flowers always had *two* spurs and *five* stamens.

A form was frequently found (not figured) which conformed exactly with that shown in fig. 5, excepting for the fact that the deep cleft which separates the purple petal from the yellow ones was less deeply cut on the one side than on the other. These flowers had at least two spurs and five stamens. Inasmuch as the distinction between the two lips is in such cases partially

absent, it may be said that this form is intermediate between No. 2 and the peloric type.

No. 3. *Flower having one posterior (purple) petal and five anterior (yellow) petals* (Plate L. fig. 7).—These flowers were not uncommon; they had *six* stamens and sometimes six sepals. None were seen with less than three spurs.

No. 4. *Flower having three posterior (purple) petals and two anterior (purplish) petals* (Plate L. figs. 16 & 17).—Of this very remarkable form only a single flower was seen. The corolla had no spur. The stamens were five in number. The filaments were not standing up in a regular arrangement, but were somewhat irregularly bent. It is not certain that this bent position of the filaments was the original one, for the anthers had already dehisced, and similar bent filaments were seen in several normal flowers after dehiscence; on the whole, however, the appearances suggested that the stamens had not been properly formed. The sepals were five in number. If this form be compared with the normal one (figs. 1 & 14), it will be seen that the symmetry is, as it were, inverted, for in this flower the posterior petals are three and the anterior petals are two, thus *inverting* the usual arrangement. In this flower, however, the three posterior petals were not closely united to form a lip, but the central one was separated by considerable clefts from the other two.

Some forms were found to which the term "monstrous" might with some propriety be applied. Chief amongst these are flowers which are built up of the parts of two flowers rolled into one. [From the analogy of other double monsters it would probably be more correct to speak of these flowers as consisting of a single flower which has partially divided into two.] This form of monstrosity is well known in many orders*, and is not very rare in *Linaria spuria*, three such flowers having been seen by us.

The peloric form of *Linaria* is perfectly well known, but the other abnormal forms which we have described do not appear to have attracted much attention.

There is, however, a good detailed account of many abnormal forms given by Chavannes†, amongst which our form No. 2 is described and figured (pl. viii. fig. 1); the instance given by Chavannes is the 3-spurred variety of No. 2, and it is remarkable

* *Vide* Masters, 'Teratology,' *sub voce* "Synanthy," p. 37, &c.

† Chavannes, 'Monographie des Antirrhinées,' Paris, 1833, pp. 54–74. *Plates.*

that his specimen of this form had only four stamens, whereas every case examined by us had five.

One form described by Chavannes (Mon. Antirrh. p. 66) is of especial interest in relation to some of the other varieties about to be described. This case is that of a 4-petalled *Linaria vulgaris*, in which there were two posterior petals and *two* anterior ones forming a lower lip with only a single inflation or "palate," which was destitute of grooves. This corolla had only *one* series of hairs in the interior. There were four sepals. The stamens are described thus :—"*Les deux antérieures soudées en une seule plus longue ; les deux autres très courtes ; la cinquième stérile, mais assez développée.*" Now on comparing this with our case of *Streptocarpus* No 4 (*vide* p. 410 and Plate LI. fig. 1, iii.), it will be seen that a similar form occurs. In our flower the stamen standing anteriorly in the median plane was to all appearances a *single* stamen, though regarded in the way common in morphological discussions it would be presumed to be formed by the union of two, just as the posterior petal of *Veronica* is presumed by Eichler (*vide* p. 397) to be formed by the union of two petals. The question now arises whether Chavannes, in saying that the two anterior stamens were "*soudées en une seule,*" meant that he believed that the single stamen had thus arisen, or was describing the actual appearance. This cannot be decided, but it is very common, and indeed usual for such modes of description to be used ; and if there had been a double anther, or a double filament, or, indeed, any outward sign of duplicity, it would surely have been specified. We are inclined, therefore, to think that there was actually "*une seule*" anterior stamen as in our *Streptocarpus* ; and in saying that this had resulted by the union of two, Chavannes not improbably is referring to the accepted view of the origin of such structures.

In a paper by Lafont *, for a reference to which we are indebted to Mr. Francis Darwin, a considerable number of abnormal flowers are mentioned as having been found on *L. vulgaris*. The enumeration given by Lafont includes eleven forms, but the description is without figures and is so brief as to be somewhat ambiguous in some cases. But of these eleven forms only two clearly correspond with those found by us in *L. spuria*, viz. the peloric form and that which we have called No. 1. It is parti-

* **Ann. Sci. Nat. (Botanique), sér. 2, tome xiv. p. 255.**

cularly to be regretted that the number of petals and stamens is not always given by Lafont. He mentions, for example, a two-lipped flower with two spurs and *six* stamens, but as the number of petals is not given it is not possible to say whether it agrees with our 6-petalled form or not. Again, he describes a two-lipped flower without spurs, but does not give the number of the stamens, which is unfortunate, since from our observations (see p. 411) there is reason for supposing that variation in number of spurs may be correlated with change in the number of stamens. It is very remarkable that among a number of varieties so large as that seen in *Linaria vulgaris* by Lafont and Chavannes, none should have corresponded with any of the several types characterized by the presence of a single posterior petal. Since this seems to be one of the most usual forms of variation in *L. spuria*, it might be expected to be frequent in an allied species. But how little importance can be attached to such *à priori* reasoning in phenomena where variation is concerned, is shown by the entire want of abnormal forms in *L. Elatine*, which is found constantly growing with and even intertwined with *L. spuria*, and which is so like it in form and colour that the two might almost pass for varieties of one species.

For a further discussion of the significance of these variations the reader is referred to the end of this paper.

II. Veronica Buxbaumii.

Variations in the floral symmetry of this plant occur with extraordinary frequency. The plant is found in nearly all stubbles and waste places round Cambridge, and with two exceptions abnormal flowers were found in every locality where an examination was made. The observations were begun on the heavy land between the Histon road and the Madingley road, and in each sample of flowers from this district there were several with only *three* petals, while a small proportion had only *two*. The details of these proportions as shown in the table on p. 397. In a plot of waste garden-land a few flowers were found with two posterior petals and a few with two anterior petals.

The two exceptional localities were both barley-stubbles on a subsoil of gravel, and in them no variation beyond change of size or tint was observed. These facts suggested that perhaps the heavy nature of the soil may have some connection with the presence of the varying forms; but amongst a small number of

flowers in the beds of the Botanic Garden a corolla of three petals was found. The beds were unfortunately weeded before a proper examination of these plants could be made *.

	No. of petals	2	3	4 (normal)	5 (posterior paired)	5 (anterior paired)
10 Oct.	First stubble-field	2	13	95	0	0
,,	2nd ,,	2	16	85	0	0
,,	3rd ,,	0	5	27	0	0
12 Oct.	4th ,,	1	5	6	0	0
,,	5th ,,	0	2	118	0	0
,,	6th ,,	0	1	30	0	0
,,	7th ,,	0	4	329	0	0
30 Oct.	First stubble again visited	6	22	230	0	1
,,	Another part of same field as foregoing	3	12	81	0	0
4 Nov.	Plot of waste garden-land.	0	0	276	7	3
9 Nov.	First stubble again visited.	0	6	67	0	0
10 Nov.	Stubble near Grantchester	0	7	152	0	0
	Totals	14	93	1496	7	4
	Percentages	1 %	6 %			

The flowers found in the two localities in which all were normal are not included in this table.

We now propose to describe the abnormal forms in succession :—

No. 1. *Corolla with five petals, two being anterior.*—According to Eichler ('Blüthendiagramme,' 1875, i. p. 210), the 4-petalled corolla of *Veronica* has been derived from the 5-petalled form of the other Scrophulariaceæ by fusion of the two posterior petals to form one. He states, further, that indications of this may be seen in the frequent occurrence of flowers with the posterior petal bilobed. For a long time no flower was found by us in which there was any suggestion of a number of petals greater than four, but at length one was found in which the *anterior* petal was paired. This specimen is shown in Pl. L. fig. 22. The posterior and lateral petals were normal. The two anterior petals were similar in colour, both having the usual pale tint of the anterior petal, but one was slightly larger than the other. In another locality three other specimens having this form were found. Two of these had a normal calyx of 4 sepals, but the third had five sepals, of which two were small and were

* In this Garden large numbers of flowers having the form of Nos. 1, 2, and 3 were since found. *Vide* p. 422.

placed together opposite the posterior petal. The stamens were normal in all.

No. 2. *Corolla with five petals, two being posterior.*—Of this type seven flowers were found in one locality. Instead of the single posterior petal of the normal flower, there were, in this form, two equal and distinct posterior petals. The rest of the petals, the stamens, and the pistil were normal. A flower of this type is shown in fig. 21. One of these flowers had a calyx of five sepals, the extra sepal being minute and placed between the two posterior petals.

Now if these examples had stood alone, according to current methods of reasoning they would have gone far to establish Eichler's proposition as to the phylogeny of *Veronica*; but taken in conjunction with the whole body of varying forms, there seems to be no obvious reason for considering any one form of variation to be due to reversion rather than any other. These remarks must not be interpreted as indicating opposition to Eichler's view, which seems in every way plausible; but the facts of the variation of these flowers do not establish it, since they could be used with equal force to establish the view that *Veronica* is descended from a plant with three or even two petals. The nature of the conclusions which may be deduced will be discussed after the whole body of evidence has been given.

No. 3. *Corolla with three petals.*—Amongst all the abnormal forms of flowers which were found, by far the largest number are those with three petals. So common are they that they seem to form about 6 per cent of the total. The petals in this type are of about equal size, and they are coloured and disposed as in fig. 19 (*v. infra*). Of these flowers some have only three sepals, as shown in the figure, while others have four sepals. Two three-petalled flowers were seen with three regular sepals and a leaf-like bract borne below the calyx, upon the pedicel of the flower. All flowers with three petals in which the stamens were noted had two normal stamens, except one specimen, in which there was a third equal stamen arising from the point of union of the anterior petals.

No. 4. *Corolla with two petals.*—Next to the form with three petals the two-petalled corolla was the most frequent of the variations, occurring in about 1 per cent. of the whole number. Such corollas have the form shown in fig. 20, being composed of two petals of similar size, one being anterior and the other

posterior. The calyx and other parts of these flowers were normal. Flowers of this type may perhaps be profitably compared with those of *Calceolaria.*

Asymmetrical flowers.—It has been stated that no flower intermediate between any of these types was found. Two flowers, however, we found which were asymmetrical, though they were in no sense intermediate between the other flowers. In each of these the anterior petal was large, like the lateral petal of a normal flower, and in one case the right-hand lateral petal was small like the normal anterior petal, while in the other it was the left-hand lateral petal which was thus reduced.

Plants were found bearing normal flowers together with one of the types of 5-petalled flowers, and the two types of 5-petalled flowers were not found together on any plant in one case. The 3-petalled and 2-petalled flowers were found together with each other and with the normal on the same plant.

Colour of abnormal flowers.—In a normal 4-petalled flower the posterior petal is dark blue, the two lateral petals are a good deal lighter in colour, while the small anterior petal is still paler, being nearly white in some flowers.

Now in many of the flowers with an abnormal number of petals the distribution of colour followed the normal arrangement; that is to say, there was one large posterior dark petal, and the colour of the other petals became paler as the anterior middle line was approached. Sometimes the transition is so abrupt as to cause the middle strip of the anterior petal (in a 2-petalled flower) to seem nearly white; while in a 3-petalled flower, in which the division between two petals falls in the middle line, the edges of each of these is the part having the pale colour. Nevertheless, besides these, in several cases the three petals were all of a closely similar tint.

These facts show that the constitution of the flower is such that the forces by which the corolla is divided into segments are of such a kind that they *may* be disposed according to the various plans described, without necessarily involving any redistribution of the colouring. Though no conclusion can be now predicated from this fact, still it should be remembered when the time comes for attempting to apprehend the nature of the forces which thus divide the corolla into petals.

As many persons are disposed to attach importance to change

of habitat and acclimatization in promoting Variation, it should be mentioned that this plant is known to be an introduced species. Professor C. C. Babington tells us that he remembers that about the year 1827 a nurseryman of Bath showed him the plant as a new annual, and he considers it likely that it was originally imported for cultivation as a garden-plant. Soon after this time the plant had spread into a good many places, and Professor Babington recollects that he was accustomed to find it growing in a single field near Cambridge. In the 'Supplement to English Botany' (1853), 2769, the question of its origin is discussed, and it is mentioned as occurring in several places in England. Since that time it has spread everywhere, being found as far north as Aberdeen; but whereever found it is essentially a weed of cultivated land. Whether abnormal flowers are as common in other localities or at other times of the year we cannot say.

III. Gladiolus Hybrids.

The next case which we propose to describe relates to changes of symmetry in the flowers of cultivated *Gladiolus*. The facts about to be presented are well known to all growers of *Gladiolus*, but, as they are of great importance in their bearing on several questions relating to variations in symmetry, it is desirable to describe them in detail.

The specimens upon which the following account is based were, firstly, a collection of Lemoine's *purpureo-auratus* hybrids in the gardens of Messrs. Davidson at Ammanford, S. Wales; and, secondly, the large stock of named varieties and seedlings of *gandavensis* in the gardens of Mr. Burrell, Cambridge. We desire to express our thanks to the proprietors of these gardens for the facilities they have thus kindly afforded us.

The *Gladioli* which are now cultivated in gardens are nearly all of hybrid origin, being chiefly descended from the hybrid form known as *gandavensis*. As to the origin of this form there is some doubt, and for the present the question may be deferred, a further discussion being given below (see p. 407). The *purpureo-auratus* hybrids have been obtained recently by Lemoine, as a cross between *purpureo-auratus* and *gandavensis*, which though a hybrid seeds readily.

On examination of a few spikes of *gandavensis*, it will be soon found that the flowers are of two different kinds. In the first

type (Plate LI. fig. 6) the three segments of the outer whorl are so disposed that *one* of them (3) is anterior and median, while the other two (1 & 5) are posterior and lateral; in this type, therefore, the median plane of the symmetry bisects the anterior segment longitudinally. The segments of the inner whorl, on the contrary, are arranged in a complementary manner, so that the single *posterior* petal (6) is median while the other two (2 & 4) are antero-lateral. In both cases a stamen stands in the middle plane of the symmetry; but in Type I. the median stamen is *anterior*, while in Type II. it is *posterior*. The symmetry of the second type seems to be that of the first inverted, for in Type II. the anterior petal of the inner whorl is median, while the two others are *postero-lateral*. The outer whorl is therefore placed so that the posterior segment is median and the other two are antero-lateral. Between these two types there are certain intermediate forms which will be described later.

The two types of flower may be found together on the same spike, or a whole spike may bear only flowers of one type. In cases in which both types occur together, it sometimes happens that one side of the spike bears flowers of one type, and the other bears flowers of the other type; in other cases, the two types occur more or less alternately on the two sides, but more usually no definite arrangement is followed. Flowers of both types, when on the same spike, are coloured alike, no matter what the colours of the spike may be; the distribution of the colouring in the two types differs in the manner to be described.

In flowers of *Gladiolus* it is usual for some of the anterior segments to be narrower than the rest, of a claw-like form, and of a colour different from that of the other segments. This difference in colour takes the form of either a striping or of a rhomboidal patch of dark or light colour upon the claw-like segments. The number of segments thus marked is partly dependent on whether the flower is of Type I. or of Type II.

In flowers of Type I. (which may be said at once to be the normal form of most, if not all, wild *Gladiolus*) either all three anterior segments 2, 3, and 4 are thus marked, or only 2 and 4 have this feature; but in Type II. either 2 alone may be marked or 1, 2, and 3 may all be marked. But if a spike bears flowers of both types, and those of Type I. have only 2 and 4 marked, the flowers of Type II. on the same spike will have *only* 2 marked.

We will now describe the attitudes of the stamens in these different forms of flower. The stamens are, of course, inserted into the bases of the segments of the *outer* whorl. As in other *Iridaceæ*, they are extrorse in their position of origin; that is to say, the side of the anther upon which dehiscence afterwards takes place is turned outwards and faces the segment from which the filament arises. This position, however, is not retained in the developed flower excepting only in the case of peloric or actinomorphic flowers, which will hereafter be described. The attitude of the stamens differs according to the type to which the flower belongs. If the perianth is arranged according to the first type, having an anterior median outer petal, the stamens will be found in very nearly every case to be standing in such a way that the anthers lie parallel to each other with their faces turned towards the anterior side of the flower. A reference to the diagram of the first type will show that, as all the stamens in this case are turned the same way, it is not possible for each of them to stand in the same relation to the segment from which it arises; and as a matter of fact it will be found that the stamen of the median anterior outer petal retains its primitive position, facing the petal, while each of the other two is rotated through 60°, so that it stands sideways to its own petal, neither facing it nor turned from it. In this way all three stamens stand facing in the same direction.

If, on the other hand, the flower be of the second type, the stamens generally assume one of three positions. In most cases the anthers do not all face the same way, but two of them, namely those of the antero-lateral segments of the outer whorl, face forwards, while the stamen of the posterior and median segment stands either in its position of origin, facing its segment, or more usually it stands sideways. In a very few flowers this stamen did also face forwards, being twisted from its original extrorse position and turned through two right angles, thus having its back to its own segment.

It is thus seen that there is very marked difference in the arrangement and symmetry of these two types of flowers, both as regards the perianth and the position of the stamens, and before describing the characters of intermediate flowers it will be well to try to realize in some degree the relation of the forms of these two types to each other.

The original ground-plan of a flower of *Gladiolus* is very

simple. The flowers are arranged in two rows, one on each side of the floral axis, and at first the two rows stand back to back. Each flower consists of a perianth composed of an outer whorl of three segments and of a similar inner whorl; of three stamens arising from the base of the segments of the outer whorl; and of three carpels. The flower arises in the axil of a spathe-like bract; and opposite to this bract is another spathe-like bract, which stands between the flower and the floral axis, having its back turned towards the axis. This latter bract is recognized by Eichler * as consisting morphologically of two bracts united; and it has been shown by Payer † that it does actually so arise in development. If all parts of the flower developed equally, this flower would be regular and actinomorphic; and if each retained its original position, they would all look upwards and the two rows would stand in one vertical plane. As a matter of fact this state of things actually occurs in a good many flowers which maintain their original regularity and position. It is of some interest to observe that these regular flowers are generally the *lowest* on the spike, that is to say, the flower which opens first ‡. Of the specimens examined a considerable proportion showed this feature; and Mr. Burrell informs us that it is frequently to be seen even amongst the best named varieties, for it is not held to constitute a defect since the regular flower can be turned downwards so as to stand in series with the other flowers on the spike. In most (? all) of these regular flowers, the stamens retain their original position, each anther being turned directly outwards.

Such, then, being the original position of the flowers, by examination of the diagrams it is seen that the flower may assume either the first type or the second, according to the plane about which its irregularity is developed. The account given by Eichler relates to *G. cardinalis*, which, according to him, develops upon what we have called the second type, but, from figures of numerous species, this type seems to be exceptional.

Firstly, the original opposite position of the two rows of flowers is forsaken as the flowers open; and each flower as it opens turns horizontally towards the other row, so that the inclination

* Eichler, 'Blüthendiagramme,' i. p. 161.

† Payer, 'Organogénie,' p. 659.

‡ In the case of several other plants, the *topmost* flower is not unfrequently peloric (*Pelargonium*, &c.).

of the two rows to each other is about 90°. This process is called by gardeners "making a face," and a perfect "face" constitutes a special beauty in these flowers. In addition to this horizontal rotation, each flower, instead of looking upwards, bends over so as to face outwards from the axis. This change of direction is associated with unequal growth of the different segments of the perianth, by which some of them become larger than others. The number of the segments which are thus distinguished from the rest varies greatly, and the degree to which this differentiation proceeds is also very different in the various kinds. As the result of this process of differentiation the perianth comes to be partially divided into a posterior portion, of which the segments are large, and an anterior lip, having one to three small segments. In some flowers this division is striking, but in others there is no very definite distinction between the anterior and posterior limbs of the perianth. In connexion with this change of position of the flower, the radial symmetry is lost, but as the flower becomes thus irregular a marked bilateral symmetry supervenes. The fact to which we now wish to draw attention is this: that the new bilateral symmetry does not in all flowers develop about the same plane, but it may, on the contrary, be produced in one of two chief ways. In the first of these types the irregular perianth is symmetrical about the plane of the floral axis; and from examination of the diagram it will be seen that this plane falls in such a manner as to bisect the *posterior* segment (6) of the inner perianth and the *anterior* segment (3) of the outer whorl. This gives a flower of the form which we have called our first type, and in it the petals 2 and 4 at least are modified, the petal 3 sometimes being marked like them.

In the flower formed on Type II. the symmetry is disposed about a different plane, which is not that of the floral axis, *but is the plane of that segment of the perianth which stands next to the segment which is in the plane of the floral axis*. It thus happens that the middle plane of the flower bisects the segments 5 and 2, thus falling anteriorly between two segments of the *outer* whorl. This is the condition in our second type of flower. In it either the segment 2 alone may be modified and unguiculate, or the segments 1, 2, and 3 may all be thus modified. The attitudes which the stamens assume depend upon the plane about which the symmetry is developed; the difference between them has already been described.

From examination of the figures given it will be readily seen that the flowers of both the types stand, when expanded, so that the median plane of their symmetry is vertical, and this position is gradually assumed as the flower matures. The period at which it is determined upon which plan the flower shall develop has not been ascertained, but there is little doubt that this occurs early in the formation of the bud, for examination of buds which were only just coloured showed that they were already formed upon one or other of the two types.

Flowers intermediate between the two types.—It has been remarked above that, of whichever type a flower may be, it nevertheless stands in such a manner that the middle plane of its symmetry is vertical. There are, however, flowers which are formed neither upon the one type nor on the other, and these flowers stand in a position which is intermediate between those assumed by flowers of the two types respectively. Among the very large number of specimens examined at Mr. Burrell's nursery, intermediate flowers were decidedly uncommon; but if an intermediate flower was found on a spike, it was usual for several other flowers on the same spike to be also of the intermediate form. A reference to the figures will at once show the characters of such intermediate flowers. The first type is characterized by the possession of *two* modified anterior segments of the inner whorl, while the second type has only one such modified segment in the inner whorl; but in the intermediate forms, one segment is as a rule fully modified both in form and colouring, while an adjacent segment of the inner whorl, which, if the flowers were of the first type, would have been similarly modified, is only partially thus differentiated, being intermediate in size and markings between the fully modified and reduced anterior segment and the large and unmodified posterior segment. It appeared that the correlation between the reduction in size and the alteration of colour in these anterior segments is very close; for in proportion as the size of the segment is increased from the narrow form of the marked petal, so does the extent and intensity of the marking diminish. In a number of cases it was seen that the position taken by an intermediate flower is such that the reduced and marked petal (fig. 4, 2) comes to lie more nearly in the anterior middle line than it would do were the flower of the first type, but it does not lie actually *in* the middle anterior line, as it would do were the flower of the second type.

This is generally but not literally true, but a few cases were seen in which the reverse was found, the partially marked petal being nearer to the middle line than the fully marked one. It was also seen that the extent to which the reduced and marked segment was displaced from the middle line was, generally speaking, inversely proportional to the degree to which the adjacent segment partook of the characters of the posterior segment; in fact the more nearly the two anterior petals were alike, the more did the flower take the position of the first type; but the greater the difference between them, the more was the position that of the second type. The position of the stamens in these intermediate flowers was somewhat various, but as a rule the anthers were turned much as in flowers of the second type. So closely does the position of the flower depend upon the degree of modification in the segments, that for a moment it seemed that perhaps the flower might be rotated into position in correspondence with some physical stimulus conveyed by the petals and varying with their size or intensity of marking. To test the existence of such a control, various portions of unopened buds were removed, but the positions assumed by the flowers on expansion differed in no perceptible way from that which they would have assumed if uninjured. Of course it must be remembered that there is no evidence as to a relation of cause and effect between the form of the flower and its position, and though for convenience we may say that flowers in which the petal 2, for example, is reduced and marked, stand so that this petal is in the median vertical plane, it might equally be stated in the converse form, that flowers placed so that the petal 2 is in the median vertical plane have this petal marked and reduced; for all that can be seen is that the phenomena of position and marking &c. are correlated.

The above description, as has been stated, applies to the ordinary garden varieties of *Gladiolus*, which are collectively known as *gandavensis*. As these are all of hybrid origin, the question naturally arises whether the two types of flower are both found in any wild species, and especially whether they occur in the parents of *gandavensis*. As to the first question, it may be replied at once that the type of flower here spoken of as the *first type* is the normal form of the flower in wild species. We

have examined plates of a very large number of species, and have found no representation of any flower corresponding to our second type. Mr. J. G. Baker, whom we have consulted on this subject, further informs us that he has never seen a wild plant having the second type of flower. Dr. M. Foster also has not met with this form in the species cultivated by him. Under these circumstances it seems nearly certain that such a form occurs very rarely if at all in wild species, and that at all events it is not the normal form of flower in the parents of *gandavensis*.

It is nevertheless unfortunate that there is doubt as to the actual parentage of *gandavensis*. Herbert * states that it is descended from *G. natalensis* (=*psittacinus*) and *oppositiflorus*; while Van Houtte, in his Catalogue for 1844, states that it was obtained from *psittacinus* and *cardinalis*. Herbert states both here and in 'Amaryllidaceæ,' p. 365, that he was unable to obtain a cross between *psittacinus* and several other species of which *cardinalis* was one. Mr. Baker, to whom we are further indebted for information on this subject, inclines to the view that Herbert was mistaken.

In all figures of these flowers which we have seen they are represented as of the first type, and, as we have stated, there is no record of flowers of the second type borne by them. It is therefore very singular that Eichler † gives the second form of symmetry as the normal form for *Gladiolus* in general, and for *G. cardinalis* in particular. As all the other authorities consulted agree in the absence of flowers of the second type in this plant, we are disposed to think that Eichler must have taken his account from a garden-hybrid. It is not a little surprising that he should have made no mention of the first type of flower, which is not only the normal form of wild species, but is also on the whole the commoner even in the garden-hybrids.

The only plate in which we have found flowers of the second type represented is the coloured plate accompanying the 'Gardener's Chronicle' for Sept. 9, 1882. This illustration gives an excellent representation of two spikes, each bearing the second type of flower. For reference to this plate we are indebted to Dr. Masters. No sufficient description accompanies this plate, but there is no reasonable doubt that the plants shown are

* Journ. Hort. Soc. 1847, p. 89.

† 'Blüthendiagramme,' i. p. 161.

garden-hybrids, which we may mention is also the opinion of Mr. Baker.

It is therefore practically certain that flowers of the second type have come into existence in *gandavensis* as a variation occurring at, or since, its constitution as a hybrid, but whether such a variation ever occurs in its parents or in other wild *Gladioli* cannot be affirmed.

In conclusion, we direct attention to the following important features of the case :—

(1) The same spike bears flowers of two types of symmetry.

(2) The second type of flower is of recent origin.

(3) The symmetry of the second type of flower is nevertheless generally perfect, and forms intermediate between the two types are comparatively rare.

(4) When the two forms occur on the same spike, the same colours occur in both, being distributed according to the symmetry of each, the distribution of the colours being as symmetrical in the one case as in the other.

(5) Intermediate forms, though rare, occur; the symmetry both of form and colour is in them intermediate between those found in the two types; and the position taken up by the flower is intermediate between the positions assumed by the flowers of either type, and its approximation to either position is generally proportionate to the approximation of its form to either type.

IV. Streptocarpus.

We have been able to examine comparatively few flowers of this plant, and no exact record was kept of the total number of flowers seen. The observations given below were made chiefly on a batch of seedling plants of the species *Rexii*, growing in pots in a stove-house, between the months of October and December of this year. Among these plants we should say that about one in every twelve flowers was abnormal, but the proportion seems to vary greatly in different species. These abnormal flowers are of very various types, but we are unable to say at present whether one of these types can be considered more prevalent than others; for we have had too few specimens of each to enable us to make any generalization.

NORMAL FLOWER.

The normal flower of *Streptocarpus Rexii* is pentamerous, with a calyx of five sepals and a corolla of five petals. The corolla is bilabiate, the upper lip consisting of two petals and the lower lip of three petals (Pl. L. fig. 23). The colour of the corolla is pale greyish blue. The petals of the upper lip are of this colour without any markings upon them, but the three petals of the lower lip are streaked with bands of dark blue. There are two perfect stamens in the normal flower, situated on either side of the odd anterior petal, and two rudimentary stamens (small barren anthers without filaments) opposite the posterior and lateral sepals. In normal flowers there is a large pit about half-way down the corolla-tube, situated in the posterior middle line, and visible from the outside of the tube as a well-marked hump. A trace of an anther is generally to be found in this pit, representing an odd posterior and median fifth stamen (Pl. LI. fig. 1).

ABNORMAL FLOWERS.—I. PELORIC OR ACTINOMORPHIC.

1. *Peloric flowers with 5 petals.*—We have only seen one flower of this type on *S. Rexii*, but we have seen several on plants of *S. polyanthus* at Kew, where they seem to be of rather frequent occurrence. In the case of *S. polyanthus* the flowers we examined differed from the zygomorphic ones in standing upright instead of in a more or less horizontal position. The corolla was perfectly actinomorphic, and all five petals had assumed the character of the petals of the *lower* lip in normal flowers, *i. e.* all were streaked with bands of dark colour. There were four fertile stamens, the posterior rudimentary stamens being perfectly developed, and equal in length to the two anterior stamens. All four stamens were united by their anthers and clasped the stigma in a ring. In the flowers we examined there was no trace of a fifth stamen. The only flower of *S. Rexii* which we have seen peloric in five parts was remarkable in having *five* perfect stamens.

2. *Peloric flowers with 4 petals.*—We have seen three or four flowers of this type, in which the calyx and corolla were reduced to a symmetry of four instead of five (Pl. LI. fig. 4). The four petals of the corolla were equal in size, and all equally marked with bands of dark blue. The stamens were arranged in the same way as those in the pentamerous peloric flowers. In the flowers we examined there was absolutely no trace of any fifth petal.

II. Abnormal Flowers, not Peloric.

3. *Flower with cruciform, 4-petalled corolla, having* one *posterior partially unmarked petal.*—Only two flowers of this type were seen (Pl. L. fig. 24). In one the calyx was in five parts, like that of the normal flower; the corolla was divided into four almost equal lobes, arranged in a cruciform manner. Three of the lobes were marked with dark blue, whilst one of them was less completely marked than the others. The four stamens were arranged in the same manner as that described above for other peloric flowers. Another flower having the same type of corolla had only two stamens as in normal flowers. The types 2 and 3 are especially interesting as showing how bilabiate, pentamerous flowers can abruptly assume a tetramerous and cruciform character, either losing their zygomorphic character altogether as in type 2, or retaining it in part as in type 3.

4. *Flowers with 4-petalled, bilabiate corolla.*—Of this type we have had three specimens, two on *S. Rexii*, the other on *Streptocarpus* sp. The corolla in these flowers consisted of two upper smaller petals without markings, and two lower, larger petals with markings. In both these flowers there was one fertile stamen only, which was situated in the median, ventral line, between the two marked petals (Pl. LI. fig. 3), and two rudimentary stamens occurred laterally. Of the nature of the calyx in these flowers we have no record.

It is difficult to see how this type can have arisen unless by a discontinuous process; for by any continuous process the median anterior petal (Pl. LI. fig. 1) must have become gradually reduced, and the two stamens (S^1, S^2) on either side of it have fused into the single median one which is found in this type (Pl. LI. fig. 3). In the specimens examined there was no trace of any anterior odd petal or of any second stamen*.

5. *Flowers with 5-petalled bilaterally symmetrical corolla; 3 petals being posterior and 2 anterior.*—The two flowers of this

* An abnormal arrangement of corolla and stamens, of an exactly analogous nature, we have observed in a species of *Æschynanthus* (*longiflora?*). This flower has usually a corolla of the same pattern as that of *Streptocarpus*, and two pairs of perfect stamens, occupying a position similar to those of the two perfect and two imperfect stamens in *Streptocarpus*. In the abnormal flower the arrangement was still perfectly bilaterally symmetrical, the corolla being bilabiate with two petals in each lip, and there were three perfect stamens—one long, unpaired, median and anterior; and two shorter, paired and lateral.

type which came under our notice had the normal number of parts to the flower arranged in an abnormal symmetry. There were only *two* larger streaked petals in the lower lip of the corolla, whilst there were *three* instead of two smaller, unstreaked petals in the upper lip. The arrangement of the stamens was only examined in one of the flowers, but in this specimen it was interesting to remark that the nature of the stamens appeared to be affected by the change in symmetry in the corolla. There were four stamens here as in normal flowers; but instead of two fertile and two infertile stamens, there was only one fertile stamen and three infertile stamens. The fertile stamen occupied a median position, between the two anterior petals of the lower lip (Pl. LI. fig. 5). The position of the rudimentary stamens is indicated in the figure. There was no hump on the corolla-tube. If we suppose that the plane of symmetry about which the flower developed had moved round to the right through $\frac{1}{10}$th of a circle from the normal, the position of rudiments is easily comprehended.

6. *Flowers with 6-petalled, bilaterally symmetrical corolla.*—Of these we have had several instances on different species of *Streptocarpus.*

(*a*) A flower from *S. Rexii*, having three petals in the upper lip instead of two, the odd median petal being somewhat smaller than the lateral ones. Stamens as in normal flower.

(*b*) Flowers from *S.* sp. ?, having four petals instead of three in the lower lip, and two in the upper lip. Stamens 3 or 5 (Pl. LI. fig. 2).

7. *Flowers with 7-petalled, bilaterally symmetrical corolla.*—Of such flowers we have only seen one specimen (Pl. L. fig. 25). The calyx consisted of seven sepals, and the corolla of four petals in the upper lip and three in the under lip. The stamens were normal. This flower might be described as one in which the posterior petals and postero-lateral sepals were each represented by two segments.

Asymmetrical Forms.—Of these there are a great diversity, and it would not be profitable here to describe them in detail. They appear to be much more frequent on some species than others; on *S. Rexii* we have found hardly any whilst on other species they are of frequent occurrence. Forms with more than the normal number of petals are asymmetrical very much oftener than forms with a reduced number of petals.

Conclusion.

In the introduction to this paper it was stated that the facts to be given bore on the question of the origin of symmetrical irregular flowers; let us now consider what that bearing is. In making the remarks which follow, it must be distinctly understood that they are put forward, not as formal theory or doctrine, but as suggestions merely, and as indications of the direction in which we must look if we hope to be hereafter entitled to formulate such definite doctrines.

It was pointed out that though modern scientific opinion has come to hold that the forms of living things have been built up by minute gradations, there is one preliminary objection to this view as applied to perfect mechanisms in general and to irregular corollas in particular, namely, that there is no evidence as to the mode by which the process of building has been, or even might have been, carried out; for indeed we can hardly suggest or even conceive a way by which, in a concrete case, a perfect mechanism can have been compiled out of minimal changes. The objection holds, that these forms are in a sense perfect, and we cannot conceive them otherwise. On the other hand, there is the difficulty that it cannot be maintained that the progress of Evolution is from one perfect form to another perfect form, until evidence shall have been found showing that this process does occur as an actual phenomenon. The facts now given, though few, are a contribution to such evidence and, in our judgment, are a sample of the kind of fact which is required to enable us to deal with the problems of Descent.

From each of the plants studied, truths of specific application may be learned; but there is one fact which they all bring out together, and that fact, which is of fundamental importance to the right comprehension of the modes of Variation, is this:—(1) *Variations which occur in such a manner as to produce a symmetrical result may be great variations and may be perfect*; and conversely that (2) *Variations which are large do often produce a symmetrical result*; and (3) *that the perfection or completeness in which a variation in symmetry occurs is not, or at least need not be, proportional to the frequency of the occurrence of the variation.*

In other words, there is evidence that perfect forms may occur as sudden variations. Hence, in any given case, of the actual

history of which nothing is known, it is unnecessary to invent a hypothetical method by which its perfection may have been achieved by the compounding of minimal changes; and to propose such an hypothesis is to gratuitously invoke difficulty. The principle which we have put third, plain as it is upon the facts of Variation, is most imperfectly recognized, and indeed, in the loose consideration so often given to this subject, the very contrary is frequently assumed.

We are therefore led to recognize that the forces which control the forms of these flowers are such, that they may vary greatly, and may, as it were, remake the flower; but the flower thus remade may again seem to be a perfect thing in the sense that the normal flower is perfect, for at least that semblance of perfection which is found in the one is likewise found in the other. What those forces are which thus control the form of the flower, and how, or why, they thus combine to form symmetrical shapes we cannot tell; but the fact that they can do so, and that this is one of their attributes, may one day be found to be the clue that shall discover to us the nature of those forces.

Certain reservations must be borne in mind.

At the outset of the study of Variation, it is at once found that argument from analogy from one organ to another, or from the case of one organism to that of another, is as yet inadmissible; for the variation of special organs or of specific forms is frequently governed by principles which, so far as we can see, are likewise specific. We are therefore conscious that it is by no means legitimate to affirm principles like the foregoing as *general* principles of symmetrical variation; but that these principles are obeyed in the special cases now under consideration is sufficiently clear. Still the fact that such principles are found operating in certain cases should at least suggest the possibility that the same principles may have been followed in other cases; and especially when a form (e. g. *Veronica*) is found whose symmetry is related to that of its presumptive allies in a way similar to that in which the varieties now described are related to their respective normals, it may not be unreasonable to suspect that variations of this discontinuous character have occurred.

There is, however, another reservation which is of more importance. In all the cases now given of a new zygomorphic symmetry arising as a sudden variation, the new form has resulted by variation from another zygomorphy already existing,

and not from a regular or actinomorphic flower. From such evidence, therefore, it would be wrong to draw conclusions as to the mode of origin of a zygomorphic flower from an actinomorphic one. Therefore, though the facts warrant the statement that a new form of zygomorphic corolla may occur as a sudden variation, this may as yet be affirmed only in the case of an irregular symmetry derived from another symmetry itself irregular. For example, the facts lead us to suspect that such an irregular, 4-petalled corolla as that of *Veronica* may have occurred as a sudden variation from the form of some 5-petalled Scrophulariaceous ancestor; but we are as far as ever from knowing how that irregular corolla of the ancestor was derived from a regular or actinomorphic form. At all events the facts now given have no direct bearing on this part of the problem.

We do not now propose to attempt a discussion of the facts in their specific bearing, for the material is not such as to entitle us to do so, still less can we aim at an analysis of the various forms of symmetry presented.

It may, however, be pointed out that the examples taken show two methods by which a change of symmetry may be effected, and it is clear that these two processes are essentially distinct phenomena. For while, in the majority of instances given, the change of symmetry comes about by an alteration in the number of the parts, the case of the variation described in *Gladiolus gandavensis* and that of *Linaria spuria* No. 2 are alike in that they exhibit a change of symmetry attained not by an alteration in the number of parts, but by the selection of a different morphological plane about which the symmetry is developed. For inspection shows that in each of these cases the normal plane of symmetry of the flower has been forsaken and a new one substituted, so that the plane about which the symmetry of the flower is arranged falls through one of the segments adjacent to that through which it normally falls, and the parts of the flower are rearranged accordingly, but the number of the parts remains unchanged. Change of number of parts may also be associated with this alteration in the plane of symmetry, as is seen in the flower of *Linaria* No. 3 (Pl. L. fig. 7). In other cases given, the change of symmetry is accomplished by a change in the number of parts. In *Veronica* for instance, though a zygomorphic arrangement of 4 petals is normal, perfectly zygomorphic arrangements of 3 and 2 petals were shown to occur, in addition to two types of symmetrical flowers each with 5 petals.

At this stage it may be well to point out that in the cases given no assistance in the interpretations of their completeness is to be derived from the suggestion that these variations are instances of reversion to an ancestral type.

To some persons it seems more easy to conceive the occurrence of a perfect variation back to an ancestral form than to a form which has not occurred in the lineal descent, and Reversion is not unfrequently invoked to account for large or complete variations, though what help is derived from such an hypothesis is not clear. It is likely that the Study of Variation will hereafter lead to and necessitate a revision of the whole question of the nature of Reversion, but this is no part of our purpose at present. It must suffice to show that the hypothesis is inadmissible in most, if not all, of the present cases. The reasons for this are two:—(1) In the case of *Linaria*, *Veronica*, and *Streptocarpus* several distinct and symmetrical forms have been shown to occur as variations. It is practically inconceivable that each of them is an ancestral form, and indeed such a suggestion is almost meaningless. Since, for example, the form *Veronica* No. 2 closely approaches the usual form of other *Scrophulariaceæ*, it might reasonably be thought to be a reversion, but the forms Nos. 1, 3, & 4 cannot also be reversions. (2) The instances in which the strongest case for the hypothesis of Reversion could be made out are probably those of the peloric *Linaria* and the peloric *Streptocarpus*. For good reasons we suppose an irregular flower to be descended from a regular one; these flowers are regular, may not they be ancestral? This is a fair suggestion, but it introduces certain difficulties. For the peloric flower, in each case, is achieved not by the production of 5 *indifferent* petals, but by the production of 5 petals each *like the normal anterior median petal*, each having in the one case a nectary, and in the other the definite striping. Now the possession of a long spur-like nectary is a character of many irregular corollas, and is commonly supposed to be one of the essential parts of the mechanism of cross-fertilization, and on the ordinary view would be held to have been developed in connexion with the irregularity of the corolla to attract the insects to the right place, for the presence of spur-like nectaries in actinomorphic flowers, as *Aquilegia*, is exceptional. Similarly the striping on the anterior petals of *Streptocarpus* may reasonably be looked on as part of the mechanism for attracting and guiding insects. Though, therefore, we do not wish

to dogmatize in such a case, it must be clear that it is not possible to hold *both*—(*a*) that the spur-like nectary or the striping of the petals are part of the mechanism for cross-fertilization which is the presumed purpose of an irregular flower, and also (*b*) that these actinomorphic or peloric flowers are reversions to an ancestral type. For our own part we prefer to look on them as cases in which each petal has taken on the form of the anterior median petal of the normal flower, just as stamens may take on the form of petals, &c.; for we are not disposed to believe that the ancestor of *Linaria*, which had a regular and actinomorphic corolla, was possessed of five spurs. This has been fully discussed by Masters *, who describes this phenomenon as "Irregular Peloria."

In some of the cases given, as in the *Veronica* and the flower of *Linaria* No. 4, no flowers were found having a symmetry intermediate between that of the variety and the normal; but in other cases, as between the two types of *Gladiolus* and between *Linaria* No. 2 and the normal, a considerable number of intermediate forms were seen. But since the descent is not from flower to flower, but from plant to plant, and since the same plant may bear normal flowers and flowers having the perfect symmetry of the variety as well as intermediate flowers, the presence of these occasional intermediate flowers in no wise enables us to avoid the conclusion that in the case of an individual flower as opposed to an individual plant the change is a sudden one. Still less does the presence of some amorphous flowers, such as occur in *Linaria* or *Streptocarpus*, at all modify the fact that the flowers are capable of assuming, and often do assume, the form of the variety in its perfection. Since, besides, these amorphous flowers are not intermediate between the normal and the perfect variety, it is not necessary for us to take cognizance of them in considering the relative numerical proportions of the intermediate form as compared with the perfect variety or the perfect normal.

The next consideration which suggests itself as a deduction from facts like these is of far-reaching consequence, and touches the nature and soundness of the received principles by which morphological facts are interpreted. It is manifestly impossible to give any adequate discussion of such a subject within the limits of this paper; and it is only on a much wider survey of

* 'Vegetable Teratology,' p. 228, &c.

the facts of Variation that the real force and legitimacy of this deduction can appear. Since, however, the facts now presented lead naturally to this question, it may be right to give a slight forecast of the line of thought which they suggest.

The whole significance, then, of facts of comparative structure, and especially of the facts of development, as applied to the study of Evolution, lies in the belief that the genetic relations of species and genera *can* be determined from this comparative study of their forms and modes of development. In other words, it is supposed that the changes by which species have been evolved from each other are of such a nature that, speaking generally, it is from time to time possible to perceive their relationships by study of their forms; and especially it is anticipated that these changes are of such a kind as to leave more or less recognizable traces of their occurrence. In proportion as it shall be found that variations occur *without* leaving such traces of the previous form of the species, to that degree will comparative study of form and development be powerless to solve the problem of Descent. Now, though it is a question which needs more investigation, it is at all events apparently true that the changes which leave traces are continuous changes, while discontinuous changes leave little or no trace; so that the principle may probably be stated thus, that in proportion as Variation is not a continuous process will comparative morphology cease to be an effectual guide to the history of Descent.

The facts of the changes seen in our flowers show, as has been said, that when a change of symmetry is concerned, Variation is constantly discontinuous, leaving no visible trace. It is therefore in the case of forms of differing symmetries that we must expect the evidence of comparative morphology to be absent or inadmissible. Yet it is precisely at this very point of alteration in symmetry that we want help as to the history of Descent. It is easy to conceive the steps between forms differing in the degree of expression of some character, such as size or intensity of colour, but in trying to pass from a form with one kind of symmetry to a form with another we often cannot even conceive the transitional steps. There are some cases in which such steps can be conceived and are assumed to have occurred. In *Veronica*, for example, when compared with other *Scrophulariaceæ*, it is supposed that the flower of the former has been derived from the latter by "fusion" of the two posterior petals, by loss of the

posterior median sepal, by abortion of stamens, and the like. The study of Variation shows how vain and inadequate this treatment is. In the *Veronica* with three petals is it supposed that there has been, firstly, division of the anterior petal into two parts, each of which has united with the lateral petals ? What is the evidence of this ? Let it be remembered that in suggesting that the posterior petal of *Veronica* has been formed by union of the two posterior petals of its Scrophulariaceous ancestor, it is certainly suggested that there has been a series of actual forms in which this union was, step by step, effected, and that the occurrence of occasional flowers with two posterior petals like our No. 2 is a proof of this. But what, then, does the flower No. 1 prove ; for in it there are two *anterior* petals ? Where are the transitional forms between the 2-petalled and 3-petalled flowers and the normal ? These forms are now arising at this moment on the very plants which bear the normal flowers, and intermediate forms, if indeed there are any, are so rare that we have found none. If there are no transitional forms in the one case, why need there have been transitional stages in the other ? *

Take, again, the case of *Streptocarpus* No. 4 : comparing it with the normal flower, it is seen that the median anterior petal is not "becoming aborted," but is *gone* (Pl. LI. figs. 1 & 3). Now if this petal had gradually disappeared, the two stamens which in the normal flower stand on either side of it would have come nearer and nearer together until, on the total disappearance of the median anterior petal, the two stamens would stand together. But in this specimen there were not *two* stamens but *one* stamen, which tells the plain story that no such process of gradual atrophy of the anterior petal has occurred at all. On the contrary, the forces which combine to make the normal flower were driven instead to make the flower No. 4, and suc-

* The following piece of evidence may not be without interest in this connexion. It is stated with regard to *Scrophularia arguta* that towards the end of summer the lowest branches springing from the stem bend downwards and penetrate the soil ; the branches immediately above the lowest ones also bend downwards, but do not always enter the earth. These branches bear fertile flowers ; those which are below the soil are completely destitute of petals ; those which are on the surface have a four-lobed corolla whose divisions are nearly equal, like those of *Veronica*. The above account is taken from Masters, 'Vegetable Teratology,' p. 334, and the original observation is recorded by Durieu de Maisonneuve in Bull. Soc. Bot. France, iii. 1856, p. 569, but unfortunately contains no information beyond that given here.

ceeded in making it, a symmetrical and perfect thing—perfect, that is to say, in the sense that the normal flower is perfect.

How, then, if the seed of this flower had been saved and a race of *Streptocarpus* having the symmetry of No. 4 had arisen? Such a thing may be possible enough. By what means would the morphologist of the future have traced the descent of this flower by comparison, and so forth? Of course we recognize that had it been possible for us to have observed the development of this flower, some indication of a change of plan might perhaps have been found; but if all trace of such a great and essential change as this is at the moment of its occurrence thrust far back into development, the prospect of finding traces now of any large proportion of the changes which happened long ago is not hopeful. We are therefore disposed to think that the first teaching of the facts of Variation is this: that *comparison* of forms is not likely to be a good guide to the history of those forms; and that there is no evidence that degrees of apparent relationship of form are an indication of degrees of actual relationship by descent; and that nothing short of an actual knowledge of the processes of Variation and a discernment of the changes which are possible to living things from those which are impossible to them, can be of any use in the solution of the problem of Descent. Until such knowledge shall have been reached, any hypothesis of the "atrophy" of parts, of the "fusion" of parts, and generally the attempt to reconstruct what is unknown, must, of necessity, be unfounded and misleading, and had better not be undertaken.

The fact that there are certain variations which are, as it were, integral, and which, if they occur at all, occur in their complete form always, or nearly always, is of course perfectly well known. Darwin* gives several cases of this as illustrations of the phenomenon that certain characters cannot blend. In particular he instances the case of peloric *Antirrhinum*, which is closely akin to *Linaria*. He states that of 137 plants raised as the second generation of a cross between normal and peloric *Antirrhinum*, only two were in an intermediate condition, while the others were all either normal or peloric. Our object now is to show that this principle is widely true of variations which are

* Anim. & Pl. 1885, ii. p. 71; see also Mélicocq, in Bull. Soc. Bot. France, 1859, vi. p. 716.

of the nature of specific changes, and to point out that it may help us to measure the size of the integral steps of Variation.

An objector may say that there is no evidence that the variations we have described are such as lead to the formation of new species and new forms. That is perfectly true; but nevertheless it is clear that they *may* be of this nature, and that new forms *might* thus originate; and while, on the other hand, there is no evidence of the occurrence of variations other than these, by which new forms of symmetry may be produced, this class of Variation is entitled to be very carefully considered. For our own part, we think, further, that evidence can be adduced to show that this class of Variation does lead to the formation of distinct forms; but this is a much wider subject and must needs be postponed for the present.

There is, however, another class of Variation which is known to occur, and space will not be wasted if we point out very briefly the relation of this other kind of Variation to that described by us. By the elaborate researches of Galton *, it has been shown that the frequency of the occurrence of certain variations obeys the Law of Error; that is to say, that, speaking generally, the greater the departure from the normal form, the rarer will be the variation. Galton has shown that this is true of several variations in size &c. of Man; and Weldon† has further established the same for variations in proportional measurements of the Shrimp (*Crangon vulgaris*), &c. Though these are the only variations which have been properly investigated by a statistical method, it may be seen by inspection that the resulting proposition cannot be true of the variations which we have been considering. For in these cases of symmetrical variations, as we have shown, the variation is frequently complete and seldom incomplete, and the perfection of the variation is out of all proportion to the frequency of its occurrence. If we suppose in the case of *Linaria spuria* that the flowers having the normal form or the form No. 2, or some intermediate form, could be arranged in a series, it would then be found that there were a great number of normals, a few intermediates, and a considerable number of flowers with the form No. 2. The form No. 2 is thus, as it were, another normal. It is no doubt true that flowers having substantially the form No. 2

* F. Galton, 'Natural Inheritances, &c.'

† W. F. R. Weldon, Proc. Roy. Soc. xlvii. 1890, p. 445.

vary also among themselves; and it is possible enough that the comparative frequency of these variations obeys the Law of Error, taking the form No. 2 as the mean form. It seems, in fact, in cases where changes of symmetry are concerned, that the intermediate forms are, as it were, points of unstable equilibrium, and that the body therefore assumes these forms rarely, as in some instances, or never, as in others. A simple illustration, though somewhat loose, may make this more clear.

The distribution of forms with regard to the normal symmetry, on the one hand, and the symmetry of the variety, on the other, may be perhaps compared with the spread of agricultural settlers into a country divided by a mountain-range. The mass of the people will settle in the nearest plain. Some will perhaps settle on the hillside, but these will be found fewer and fewer as the range is ascended; but those who get over the top of the range will mostly go down into the plain beyond. Those in the hither plain are many and are the normal; those in the valley beyond are the variety, and the few on the hillsides are the intermediates.

We wish, then, to insist upon the fact that there are at least two classes of variation; and it is suggested that this is a fact of great importance. It may be remarked that if, as may be alleged, there is little evidence that species may arise by what may be called discontinuous variation—a variation in kind—there is still less evidence that new forms can arise by those variations in degree which at any given moment are capable of being arranged in a curve of Error; and no one as yet has ever indicated the way by which such variations could lead to the constitution of new forms, at all events under the sole guidance of Natural Selection. Whatever may be hereafter determined as to the scope of either of these classes of variations in the constitution of Species, it is of the first consequence to recognize that these two classes of variation exist; and the problem of the history of any given form or structure will never be solved until it shall have been first determined whether it is the result of the one class of Variation or of the other, and whether the changes which produced it were continuous or discontinuous.

NOTE.—The observations above recorded were made a year ago, and as since that time the case of *Veronica* has been much more fully investigated, a brief abstract of these observations may here be added.

In *Veronica Buxbaumii* 3-petalled flowers are common on all soils and in many gardens round Cambridge, though entirely absent in a few localities according to our experience. This type most frequently has 4 sepals, but 3-sepalled specimens are not rare. Flowers with 5 petals having the form either of No. 1 or No. 2 are also fairly common, especially in gardens. Speaking generally, there are in garden soil not less than 1 per cent. of each of these forms in many localities. Several forms of *asymmetrical* corollas have been seen, but they are rare and are generally associated with petalody of stamens. The latter phenomenon is rare, and is seen especially in the case of certain dwarfed corollas which are sometimes found. These curious flowers are very interesting, but cannot be satisfactorily described in so short a note.

In the Cambridge Botanic Garden the two kinds of 5-petalled flowers are very common on *V. austriaca*, *V. rupestris*, and *V. pectinata*. In the patch of the last-named form at the Gardens abnormal flowers are as frequent as normal ones, and about a quarter have petalody of one or both stamens or other complex malformations. "Synanthy" is also common in this form.

On *V. Chamædrys* two flowers of the 3-petalled type were seen this year on separate plants. The 5-petalled form of flower with two posterior petals also was found sparely. Abnormal flowers in this species appear to be decidedly rare.

25th October, 1891.

EXPLANATION OF THE PLATES.

Plate L.

Figs. 1–17. *Linaria spuria*; normal and abnormal flowers.
(For simplicity the hairs on the sepals are mostly omitted.)

Fig. 1. Normal flower, seen from in front.
2. Normal flower, seen from the side.
3. Flower having corolla normally divided, but with two spurs instead of one (and five complete stamens).
4. Flower intermediate between that shown in fig. 3 and that shown in fig. 5 (rare).
5. Abnormal flower, No. 2 (in text).
6. Abnormal flower, similar to that shown in fig. 5, but having three spurs instead of two.
7. Abnormal flower, having one posterior petal and five anterior ones—six in all.

In figs. 5, 6, and 7 the anterior sepal is not shown.

Bateson.

VARIATIONS IN FLORAL SYMMETRY.

J.N. Fitch lith et imp.

VARIATIONS IN FLORAL SYMMETRY.

Figs. 8, 9, 10, 11. Various forms of actinomorphic (peloric) corollas, seen from above. That shown in fig. 10 has six petals.

Fig. 12. Actinomorphic flower with all the spurs invaginated into the tube at the points *s*.

13 *a*. Corolla which is actinomorphic as regards the size of the petals and the division of the tube, but having the posterior petal folded back and the corolla bent upwards, as shown in the figure.

13 *b*. The same flower, from the side.

14. Actinomorphic (peloric) flower having five spurs, all evaginated.

15. Actinomorphic flower having six petals and six spurs, all evaginated.

16. The abnormal flower described in the text as No. 4. Only a single flower of this pattern found. It has three posterior (purple) petals and two anterior (purplish) petals. Seen from in front.

17. The same, seen from the side, showing complete absence of spur.

Figs. 18–22. *Veronica Buxbaumii*, normal and abnormal flowers.

Fig. 18. Normal flower.

19. Three-petalled flower (about 5 per cent., see p. 398).

20. Two-petalled flower (about 1 per cent.).

21. Five-petalled flower, two petals being posterior.

22. Five-petalled flower, two petals being anterior.

Figs. 23–25. Figures of *Streptocarpus Rexii*, normal and abnormal.

Fig. 23. Normal flower.

24. This flower had four petals, three being fully marked as normal anterior petals are, the posterior petal being less marked. Four perfect stamens and *five* sepals, one being posterior and median. This flower was therefore intermediate between a normal flower and the peloric flower with four parts. *Cf.* Pl. LI. fig. 4.

25. Flower having three anterior marked petals and four posterior unmarked petals. This flower has seven sepals in correspondence with the seven petals, but the stamens were as in the normal flower, viz. two perfect and two aborted.

Plate LI.

Figs. 1–5. Diagrams showing the disposition of the corolla and stamens in *Streptocarpus Rexii*. The ovaries are not shown, as their relation in the abnormal cases was not satisfactorily made out. In each case the petals which were marked like the normal anterior petals are blackened.

Fig. 1. Normal flower: two posterior and three anterior petals.

2. Flower having three posterior and three anterior petals. Corolla and stamens only.

3. Flower having two posterior and *two* anterior marked petals. Observe that in this flower a single stamen stands anteriorly, *in the plane about which the flower is symmetrical*; while in a four-petalled flower, like

fig. 24, in which all the petals are marked, there are four complete stamens.

Fig. 4. Flower having three posterior petals and *two* anterior petals. Only one stamen is developed. The axis is not shown in this case, as its relation was not satisfactorily made out, but the attitude of the flower was that indicated in the diagram.

5. Actinomorphic (peloric) flower with four petals, sepals, and stamens. *All* the petals were marked as anterior petals of the normal flower.

6. Conventional representation of the parts of the flower in the two types of *Gladiolus gandavensis*, showing the planes about which their zygomorphy develops in each case respectively.—N.B. The anthers are shown in the positions which they commonly assume in the expanded flowers of each type. In flowers of type II. the anther *b* not infrequently retains its position of origin, *facing* the segment 5; rarely it turns completely round so as to face the segment 2. The "unguiculate" segments are shaded darkly.

7. *Gladiolus gandavensis*, Type I., from same spike as fig. 4 (from a photograph).

8. *Gladiolus gandavensis*, Type II., from the same spike as fig. 3 (from a photograph).

Both are from the same side of the spike.

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ERRATA.

Page 287, line 7 from bottom, for *aratica* read *araratica*.
„ 318, first column, line 4, *for* terniflorum, *Linn.*, *read* tenuiflorum, *Linn. f.*

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,, ,, February 4		,, ,, March 3	

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